SCHOOL OF PSYCHOLOGY – DOCTORATE IN CLINICAL PSYCHOLOGY

MAJOR RESEARCH PROJECT

LITERATURE REVIEW: Repetitive Negative Thought and Anhedonia: A Systematic Review

EMPIRICAL PAPER: Repetitive Negative Thought and Reward Sensitivity

Submitted by **Ruth Burrows-Kerr**, to the University of Exeter
as a thesis for the degree of **Doctor of Clinical Psychology**, May 2015

Signature: ……..

Author's Declaration

The literature review was completed independently by the author.

All elements of the empirical paper were completed independently by the author with two exceptions. Firstly, the reward sensitivity task was provided as a package by Diego Pizzagalli. Secondly, the reward sensitivity task analysis (e.g., reaction times, number of valid trials) and data reduction (e.g., calculating accuracy, response bias and discriminability scores) was carried out by Diego Pizzagalli's research team.

Table of Contents

List of Tables

Literature Review

Empirical Paper

List of Figures

Literature Review

Empirical Paper

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LITERATURE REVIEW

Repetitive Negative Thought and Anhedonia: A Systematic Review

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Abstract

Anhedonia, the loss of interest or pleasure in usually pleasurable activities, is a core symptom of depression and is associated with a reduction in positive affect (PA). Repetitive negative thought (RNT) is implicated in the development and maintenance of psychiatric disorders. It has been hypothesised that RNT causally contributes to anhedonia. The aim of this review was to explore this relationship to answer two questions: Is there a relationship between RNT and anhedonia? Does RNT causally contribute to anhedonia? Review inclusion criteria were: studies using standardised measures to report a relationship between RNT and anhedonia or reduced PA. Results suggest that cross-sectional and longitudinal studies identify a relationship between RNT and anhedonia. Preliminary evidence from experimental studies shows that RNT causally contributes to anhedonia. Limitations within the field are that anhedonia is rarely measured directly or behaviourally. Future research is warranted to explore the relationship between RNT and anhedonia with a particular focus on direct and behavioural measures of anhedonia.

Keywords

Anhedonia, Positive Affect, Repetitive Negative Thought, Repetitive Thought, Rumination, Worry

Introduction

This review considers the potential relationship between two characteristic features of depression – anhedonia and rumination. Both have been implicated in the maintenance of depression and recent theories have suggested a potential link between them (e.g., Watkins, 2013). In this paper, this relationship is systematically reviewed.

Anhedonia was first introduced as a term by Ribot (1896) to describe loss of pleasure. The Diagnostic and Statistical Manual for Mental Disorders (DSM-IV-TR; American Psychiatric Association [APA], 2000) defines anhedonia defines anhedonia as reduced ability of stimuli to be rewarding that have previously been found to be rewarding, i.e., a diminished interest or pleasure in response to stimuli that were previously perceived as rewarding during a pre-morbid state. It is a core symptom of depression (APA, 2000) and it is estimated that 37% of individuals with a diagnosis of depression experience anhedonia (Pelizza & Ferrari, 2009). It is also considered a risk factor increasing vulnerability to depression (Costello, 1972; Meehl, 1975).

Reward contains multiple psychological components, of which the key components relevant to this review are: a) the affective consequences of rewards, i.e., “liking”, related to satiation and in-the-moment pleasure (Berridge & Robinson, 1998, 2003); and, b) the motivational consequences of rewards, i.e., “wanting”, in which incentive salience increases with increased goal-directed activity targeting desired outcomes e.g., craving (Berridge & Robinson, 1998, 2003). The affective and motivational consequences of rewards are dissociable because “wanting” can be manipulated without changing “liking” (Berridge & Robinson, 2003).

In turn, the distinction between “liking” and “wanting” in the non-clinical literature broadly maps onto the distinction between deficits in the hedonic response to rewards (“consummatory anhedonia”, i.e., not enjoying receiving previously rewarding stimuli) and a diminished motivation or drive to pursue them (“motivational anhedonia” – with an anticipatory component; Treadway & Zald, 2011).

It has been hypothesized that motivational impairments in MDD arise from deficits in processing related primarily to “wanting” and anticipatory pleasure rather than to “liking” and consummatory pleasure (Dichter, 2010); although there has been limited empirical testing of “wanting” vs. “liking” in depressed patients. For example on “sweet taste test” paradigms in which participants rate the pleasantness of different sucrose concentrations, no differences in reported hedonic impact are found between patients with depression and matched controls (Amsterdam, Settle, Doty, Abelman, & Winokur, 1987). Using decks of humorous versus non-humorous cartoons, Sherdell, Waugh, and Gotlib (2012) used an effort measurement task (number of clicks required on a computer square to receive a cartoon) and self-report ratings to investigate preference, “liking” and “wanting” for rewarding stimuli in depressed patients versus controls. Anticipatory anhedonia significantly predicted motivation (effort) in a negative direction within the depressed patients. MDD and control participants did not differ in their consummatory response to reward. Animal models of anhedonia have shown that dopamine is involved in anticipatory processing, but less involved in the consummatory response to reward (Berridge & Robinson, 1998, 2003). Thus, it is proposed

that dopamine plays a role in regulating behavioural activation (Sherdell et al., 2012).

A neurobiological substrate hypothesised to control appetitive motivation is the behavioural activation system or behavioural approach system (BAS; Gray, 1981; Fowles, 1980). The BAS is hypothesised to be sensitive to reward and to underpin approach to reward, and is proposed to be responsible for positive affect (PA; Gray, 1981). Depue and Iacono (1989) proposed that this reward-based behavioural approach system is under-activated in depressed individuals, accounting for symptoms of depression. Anhedonia and reduced PA are both characteristics of reduced behavioural activation often found in depression (Clark, Watson, & Mineka, 1994; Watson, Clark, & Carey, 1988, Watson et al., 1995; Davidson & Henriques, 2000; Henriques & Davidson, 2000; Pizzagalli et al., 2009). Anhedonia and reduced PA are also correlated with each other (Clark & Watson, 1991). Clinically, reduced behavioural activation could lead to reduced engagement in pleasurable activities and diminished responsiveness to reward; which, in turn, increases depressive symptoms such as loss of pleasure, appetite, libido, and interest in the environment (Pizzagalli et al., 2009). The mechanisms underpinning anhedonia in depression have not yet been fully explored. One potential mechanism that has been hypothesised is repetitive thought (e.g., Watkins, 2013).

Repetitive thought (RT), defined as “the process of thinking attentively, repetitively, or frequently about oneself and one’s world” (Segerstrom, Stanton, Alden, & Shortridge, 2003, p. 909), is a common process in psychopathology and self-regulation and can have constructive and

unconstructive effects on cognition and emotion (Watkins, 2008). Depressive rumination and worry are the most common forms of maladaptive RT (i.e., repetitive negative thought; RNT) and are implicated in the development and maintenance of psychiatric disorders (Segerstrom et al., 2003). RNT is hypothesised to be a transdiagnostic process, which is present in a number of psychiatric diagnoses (e.g., depression, generalised anxiety disorder, social anxiety and post-traumatic stress disorder) and has a causal contribution to these diagnoses (Harvey, Watkins, Mansell, & Shafran, 2004; Ehring & Watkins, 2008; Watkins, 2013). Some types of RT (not including depressive rumination and worry) can be adaptive and play a role in problem-solving and recovery from distressing events (Watkins, 2008; 2013).

Rumination is a key construct in depression (Nolen-Hoeksema, 1991) and is defined as "behaviours and thoughts that focus one's attention on one's depressive symptoms and on the implications of these symptoms" (Nolen-Hoeksema, 1991, p. 569). It has also been conceptualised as a process of RT triggered by unresolved personal goals and concerns that can be constructive or unconstructive, depending on whether the RT helps resolve the goals or not (Watkins, 2008).

"Worry is a chain of thoughts and images, negatively affect-laden and relatively uncontrollable" (Borkovec, Robinson, Pruzinsky, & DePree, 1983, p. 10). Worry is a process conceptualised as an attempt to avoid negative outcomes through problem-solving and preparing for the worst and is often linked to an increase in negative affect (anxiety and depression; Borkovec, Ray, & Stöber, 1998). Worry can also have constructive effects, for example orientating the individual to potential threat or difficulties (e.g., studying for an

exam), but only if the worry is objective, controllable, and brief (Tallis & Eysenck, 1994).

RNT is hypothesised to reduce responsiveness to information that does not relate to the content of RNT (Stein, Lehtonen, Harvey, Nicol-Harper, & Craske, 2009; Watkins, 2008, 2011); when processing information, selective attention allows the individual to process the most relevant information (Lehtonen et al., 2009). If an individual is engaged in RNT then they are likely to be focused internally (focused "in the head") on the themes of the RNT rather than externally (focused "on the world"). Thus, their focus of attention is drawn away from the environment or towards evaluating the implications of their situation, which leads to reduced engagement with the external environment. This, in turn, could contribute to anhedonia by reducing contact with positive reinforcers and awareness of positive contingencies in their environment (Watkins, 2013). The aim of this review is to explore this hypothesised relationship between RNT and anhedonia within the empirical literature, focusing on the following questions:

1. Is there a relationship between RNT and anhedonia?
2. Does RNT causally contribute to anhedonia?

Method

The Preferred Reporting Items for Systematic reviews and Meta Analyses (PRISMA) Statement guidelines for reporting a systematic review were followed while completing all stages of this review (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

Eligibility Criteria

Types of studies. The three types of study considered for inclusion were: a) cross-sectional designs in which a measure of RNT was found to be correlated with a measure of anhedonia; b) prospective longitudinal designs that measured RNT at initial assessment point and examined whether it predicted anhedonia at a later assessment point, usually controlling for anhedonia at initial assessment; and c) experimental designs that manipulated RNT and measured the effect on anhedonia.

Types of participants. Participants of all ages were included. Participants were included regardless of whether they were from clinical or non-clinical populations.

Types of measures. Studies were included in this review if they reported a relationship between RNT and anhedonia. RNT was operationalised as repetitive thoughts about negative topics that are difficult to control (Ehring & Watkins, 2008). Within this operationalisation, RNT manipulations and standardised measures of RNT were considered suitable for inclusion (including, but not limited to these questionnaires: the Ruminative Response Scale of the Response Styles Questionnaire [RRS: RSQ; Nolen-Hoeksema, 1991], the Penn State Worry Questionnaire [PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990]). In addition, non-standardised questions designed to measure RNT in experience sampling studies were also included.

Anhedonia was operationalised as direct reports of loss of interest or pleasure in pleasurable activities or lack of responsiveness to rewarding stimuli. Within this operationalisation, behavioural measures of anhedonia (e.g., laboratory-based behavioural measures of anhedonia) and standardised

measures of anhedonia were considered suitable for inclusion (including, but not limited to these questionnaires: anhedonic depression as measured by the Mood and Anxiety Symptom Questionnaire [MASQ; Watson et al., 1995], the Snaith-Hamilton Pleasure Scale [SHAPS; Snaith et al., 1995]); Beck Depression Inventory [BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961] items associated with anhedonic symptoms).

Studies were also judged to be relevant where standardised measures of positive affect (PA; e.g., the Positive Affect scale of the Positive and Negative Affect Schedule; PANAS; Watson, Clark, & Tellegen, 1988) or single-item questions of PA in experience sampling studies showed a reduction in PA in direct relation to a pleasurable activity, i.e., less PA than would be expected to a positive event. PA is negatively correlated with anhedonia (Clark & Watson, 1991), and, the BAS is considered to be responsible for both, thus, reduced PA provides a proxy measure of anhedonia, although it is not a direct measure.

Exclusion criteria. Papers that are not written in English will be excluded. Review and theoretical papers will also be excluded.

Information Sources

Relevant publications were identified for this review using a computerised search of the following databases: EBSCO, OVID[1], Web of Science and MEDLINE: PubMed, from the beginning point of each database through to February 2015.

[1] The OVID database search included the following databases: PsycARTICLES, Embase, Global Health, HMIC Health Management Information Consortium, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R), Ovid MEDLINE(R) Daily Update November 19, 2014, Journals@Ovid, Your Journals@Ovid, PsycINFO, and Social Policy and Practice.

Search

Titles and abstracts[2] in all databases were searched to identify publications reporting a relationship between RNT and anhedonia. Table 1 details search terms entered for RNT and anhedonia (using wild cards such as ruminat* for ruminate, rumination, ruminator, ruminative). The search terms for RNT were combined with those for anhedonia using the Boolean operator "AND" (see Table 1). In addition, the reference lists of the included articles, review articles (and chapters) and seminal articles (e.g., Killingsworth & Gilbert, 2010; Nolen-Hoeksema, 2000; Stein, Lehtonen, Harvey, Nicol-Harper, & Craske, 2009; Watkins, 2013) were reviewed for relevant publications.

Study Selection

Titles and abstracts of all articles identified were initially screened to see if they met the eligibility criteria. Relevant articles were then read in full and again assessed against the eligibility criteria. A randomly selected 10% of the studies read in full were then assessed against the eligibility criteria by an independent clinical researcher. No difficulties were experienced gaining access to full texts of relevant articles and all relevant articles were written in English.

Data Extraction

Data were extracted from the studies using the population, intervention, control, outcomes (PICO; O'Connor, Green, & Higgins, 2011) method and summarised in Table 2. The studies were assessed for quality using the Quality Assessment Tool for Quantitative Studies (QATQS; Effective Public

[2] MEDLINE PubMed returned zero results in titles and abstracts, therefore all fields were searched.

Health Practice Project, 2009, see Appendices A & B). Studies were assessed in relation to selection, performance, measurement and attrition biases.

Organisation of Review

The review will be organised by study design, with greater weight given to studies using an experimental or prospective longitudinal design as they demonstrate that the dependent variable (anhedonia or PA) is a consequence of RNT, either with a direct causal role of RNT (experimental) or a predictive function of RNT for the dependent variable (prospective longitudinal).

Results

A total of 664 citations resulted from the search terms across the databases searched. Of these citations, after removal of duplicates and screening of titles and abstracts, 27 full-text papers were read and assessed to determine whether they met the inclusion and exclusion criteria. Ten further articles were identified from reviewing reference lists and citations of these articles and seminal papers and texts as outlined previously. 20 articles were excluded for violating the eligibility criteria, resulting in 17 papers for review (see Figure 1).

Table 1

Search Terms Entered in Databases

	RNT	Anhedonia
Search Terms	*ruminat*, worry, repetitive thought, perseverative cognition, cognitive processing, emotional processing, problem solving, mental simulation, counterfactual thinking, defensive pessimism, reflection, mind wandering, habitual negative self-thinking, and preoccupation**	*anhedon*, loss of interest, loss of pleasure, positive affect, reward sensitivity, response bias, and hedonic capacity***
Search Terms Combined	(ruminat* OR Worry OR "Repetitive Thought" OR "Perseverative Cognition" OR "Cognitive Processing" OR "Emotional Processing" OR "Problem Solving" OR "Mental Simulation" OR "Counterfactual Thinking" OR "Defensive Pessimism" OR Reflection OR "Mind Wandering" OR "Habitual Negative Self-Thinking" OR Preoccupation) AND (anhedon* OR "loss of interest" OR "loss of pleasure" OR "positive affect" OR "Reward Sensitivity" OR "Response Bias" OR "hedonic capacity")	

Note.

*reflecting prior reviews, (e.g., Segerstrom, Tsao, Alden, & Craske, 2000; Watkins, 2008)

**American Psychiatric Association (2000); Meehl (1975); Pizzagalli, Jahn & O'Shea (2005).

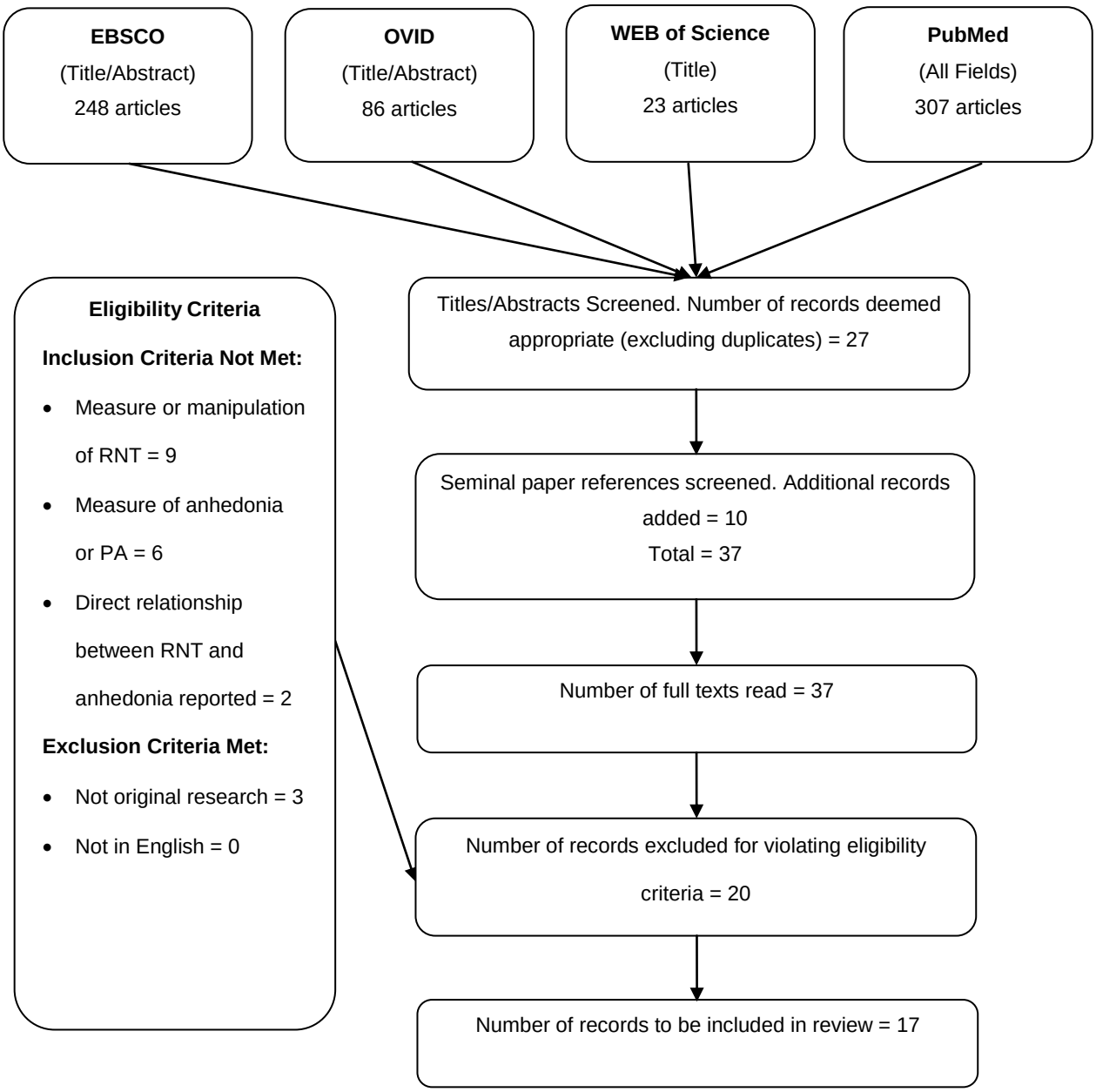

Figure 1. Search strategy and process of identification, screening, eligibility and inclusion for review.

Table 2
Studies included in the review, including study characteristics, measures, relevant main findings and critical evaluation.

Author	Design and Aims	Sample	Measure	Main Findings relating to RT & Anhedonia, with Effect Sizes	Evaluation	QATQS ratings (see note for abbreviated ratings)
			Cross-sectional Studies			
Nelson & Mazure (1985)	Cross-sectional study looking at association between rumination and melancholia	71 inpatients with MDD	Clinician prospective ratings for ruminative thinking; DSM-III criteria for melancholia.	53% of melancholic depressed patients were ruminative in comparison to 11% of non-melancholic depressed patients. Symptom of rumination predictive of melancholia. Effect size: likelihood of melancholic depressed patients displaying rumination in comparison to non-melancholic depressed patients, *r* = .4	**Strengths:** Combination of clinical interview and observation of rumination, diagnostic criteria used for melancholia (key feature anhedonia). Clinical sample. **Limitations:** Small sample sizes in each group.	A – Strong B – Moderate C – Weak D – Moderate E – Strong F – N/A **OVERALL: Moderate**
Sailer et al. (2014)	Observational Cross-Sectional design looking at time perspective, life satisfaction and psychological well-being.	453 participants, 324 u/g, 129 gym attendees, 300 females, mean age 29.74.	ZTPI; TSWLS; PANAS; SPWB	Past-negative scale from ZTPI counter-predicted PA. Effect size: negative correlation between past negative scale and PA, *r* = -.32	**Strengths:** Large sample from varied sources, standardised measures. **Limitations:** Indirect measure of anhedonia, self-report measures vulnerable to demand effects and recall bias correlational design does not allow causal explanations.	A – Strong B – Moderate C – N/A D – Moderate E – Strong F – N/A **OVERALL: Strong**
Tanimukai, Hirai, Adachi, & Kishi (2014)	Observational Cross-Sectional Study looking at insomnia, worry and depressive symptoms in patients with haematological malignancies and their family members.	153 cancer patients, 80 men, average age 57± 12yrs; 112 family members of cancer patients, 76 females, average age 52±14yrs	5 questions relating to worry: "Do you have any worries related to disease as follows, Present/prospective disease conditions Yes / No Adverse effects associated with treatments Yes / No Change in daily activities at work and/or home Yes / No About family or patients Yes / No Economic matters Yes / No" 1 question relating to anhedonia: "During past two weeks, have you often been bothered by little interest in doing things?" with response options: None /not particularly/mild/severe/very	There was a significant association between worry about economic matters and depressive mood and anhedonia combined (Effect size: Family members displaying depressive mood and anhedonia were more likely to have worries about economic matters than those not displaying depressive mood and anhedonia, OR = 3.4, CI 1.3–8.6) and with anhedonia alone for family members (Effect size: Family members displaying anhedonia alone were more likely to have worries about economic matters than those not displaying anhedonia, OR = 3.1, CI 1.2–7.7), but not other worries. There was a significant association with worry about present/prospective disease and depressive mood and anhedonia combined,	**Strengths:** Good sample sizes **Limitations:** Non-standardised self-report measures of RNT or anhedonia, vulnerable to demand effects and recall bias, patients and family members not matched; significant differences in age and sex between patients and family members could account for differences between groups. Sample sizes may not be large enough for logistic regression.	A – Weak B – Moderate C – Weak D – Moderate E – Weak F – N/A **OVERALL: Weak**

Author	Design and Aims	Sample	Measure	Main Findings relating to RT & Anhedonia, with Effect Sizes	Evaluation	QATQS ratings (see note for abbreviated ratings)
			severe 1 question relating to depression: "During past two weeks, have you often been bothered by feeling down or depressed?" with response options: None /not particularly/mild/severe/very severe Further questions relating to sleep difficulties and insomnia not relevant to this review.	but not with anhedonia alone for patients. Effect size: Patients displaying depressive mood and anhedonia were more likely to have worries about present/prospective disease than those not displaying depressive mood and anhedonia, OR = 4.0, CI 1.0–15.7)		
Zou & Abbott (2012)	Cross-sectional design, baseline measures, social task in groups of 4 (2 socially anxious, 2 low social anxiety), SAR & PANAS, rate each other's performance, given false high or moderate score by researcher, SAR & PANAS, complete PQ, delay 10 mins then complete TQ.	80 predominantly u/g participants, social anxious group (met criteria on ADIS-IV; N=40, 28 females, mean age 20.83), low social anxiety (control) group (score <15 on SIAS; N=40, 26 females, mean age 20.45)	APD-IPDE; SIAS; SPS; BFNE; DASS-21; PANAS; adapted version of SAR; adapted version of PQ; Post-event rumination (positive and negative scales) measured using adapted version of TQ	Socially anxious participants displayed higher levels of NR in comparison to control group. Within socially anxious group moderate scores produced higher levels of NR than high scores, whereas no difference in control group. PA scores were significantly associated with increased levels of negative post-event rumination. Effect size: negative correlation between PA and NR, *r* = -.16.	**Strengths:** Good sample size, control group, experimental design allowing for causal explanations, standardised measures **Limitations:** Indirect measure of anhedonia, predominantly u/g population.	A – Strong B – Moderate C – Strong D – Moderate E – Strong F – N/A **OVERALL: Strong**
			Longitudinal Studies			
Brans, Koval, Verduyn, Lin Lim, & Kuppens (2013)	2 Experience sampling studies looking at 6 emotion regulation strategies and their associations with changes in PA and NA in daily life. Carried out over 7 days	Study 1: 46 participants, 25 females, mean age 21.57. Study 2: 95 u/g participants, 59 females, mean age 19.06	Study 1: PA measured using 2 adjectives, happy and relaxed on 6-point Likert scale "At the moment I feel [happy/relaxed]". Emotional regulation strategies (reflection, reappraisal, rumination, social sharing, expressive suppression and distraction) measured on 6-point Likert scale by questions starting with "Since the last beep..." and ending with "I couldn't stop thinking about my feelings" for rumination. Study 2: CES-D; PA measured as study 1, but on a slider scale from	Study 1: Rumination was associated with significant decrease in PA. PA did not predict change in use of any emotion regulation strategies. Study 2: Replicated study 1. The effect was moderated by gender, it was more pronounced for females than males PA predicted a decrease in rumination Effect sizes: not available.	**Strengths:** Large sample across 2 studies with different populations, findings replicated; ecologically valid methods; generalisable. **Limitations:** Indirect measure of anhedonia; Measures of RNT and PA limited to single item self-report questions, vulnerable to demand effects, although appropriate for the study design.	A – Strong B – Moderate C – N/A D – Moderate E – Strong F – Strong **OVERALL: Strong**

Author	Design and Aims	Sample	Measure	Main Findings relating to RT & Anhedonia, with Effect Sizes	Evaluation	QATQS ratings (see note for abbreviated ratings)
			0-100. Emotional regulation strategies as Study 1 with slightly different wording (e.g., "did you ruminate about your feelings" for rumination) and rated on a slider scale from 0-100.			
Ciarrochi & Scott (2006)	Prospective longitudinal design looking at effects of difficulty identifying emotions, ineffective problem orientation and ineffective emotion management (e.g., rumination) on PA 1 year later. Recruitment carried out over 3 years, PA only measured in 2nd year of study.	106 u/g participants, 93 females, mean age 21.22 for correlational analyses reduced to 56 participants for regression analyses	POS; ECQ; TAS-20; DASS; PANAS-X joviality scale	Greater levels of rumination at time 1 predicted decreases in PA at time 2 (1 year later) even when controlling for time 1 PA. The findings suggest that rumination predicts unique variance in PA more reliably than other emotional competence variables. Effect size: negative correlation between time 1 rumination and time 2 PA, r = -0.29	**Strengths:** Good sample size, study design allows for causal explanation **Limitations:** Indirect measure of anhedonia; Self-report questionnaires, vulnerable to demand effects and recall bias; does not control for any confounding variables between time 1 and 2.	A – Moderate B – Moderate C – N/A D – Moderate E – Strong F – Strong **OVERALL: Strong**
Killingsworth & Gilbert (2010)	Experience Sampling Study looking at mind-wandering, mood and daily activities. Up to 50 random samples taken per participant.	2250 adults, 58.8% male, 73.9% residing in USA, mean age 34yrs	VAS – good to bad "How are you feeling right now?" "What are you doing right now?" endorsing 1 or more of 22 items. Mind-wandering question: "Are you thinking about something other than what you are currently doing?"	Mind wandering occurred frequently in 46.9% of the samples and in at least 30% of samples in every activity except making love. Less happy when mind-wandering. Considerably less happy when mind-wandering to neutral or unpleasant topics. Effect sizes: mind-wandering explained 10.8% of within-person variance in happiness (Adj. R^2 = 0.11), and 17.7% of between-person variance in happiness (Adj. R^2 = 0.18).	**Strengths:** Large sample size, ecologically valid methods, generalisable. **Limitations:** Measures of RT and Anhedonia limited to single item self-report questions, vulnerable to demand effects, although appropriate for the study design.	A – Strong B – Moderate C – N/A D – Moderate E – Strong F – Moderate **OVERALL: Strong**

Author	Design and Aims	Sample	Measure	Main Findings relating to RT & Anhedonia, with Effect Sizes	Evaluation	QATQS ratings (see note for abbreviated ratings)
Pasyugina, Koval, De Leersnyder, Mesquita, & Kuppens (2014)	Experience sampling study looking at level vs. impact of rumination and how they predict change in depressive symptoms. Carried out over 9 days	101 participants (predominantly u/g), mean age 21.4	CES-D; RRS; current affect measured by the question "how [sad/stressed/anxious/disappointed/happy/relaxed] do you feel at the moment?" on a scale from 0-100, rumination measured by 2 questions: "since the previous beep, how much have you [ruminated/focused on your feelings]?"	Rumination was associated with decrease in PA. Effect sizes: correlation between Level of rumination and impact of rumination on PA, *r* = 0.16.	**Strengths:** Good ecological validity and sample size, standardised measures **Limitations:** Indirect measure of anhedonia; issues with generalisability due to predominantly student non-clinical sample; momentary rumination may not capture true nature of rumination, PA and rumination measured concurrently, thus cannot determine causation.	A – Moderate B – Moderate C – N/A D – Moderate E – Strong F – Strong **OVERALL: Strong**
Starr & Davila (2012)	Daily Diary Study looking at whether daily anxious mood precedes daily depressed mood and whether daily GAD symptoms (worry) precede depressive symptoms (anhedonia). Carried out over 21 days.	55 participants meeting DSM-IV criteria for GAD, 49 females, mean age 28.76	SCID-IV (anxiety and mood disorders modules; past and current); Daily Diary questions on 10-point Likert scales: "How [anxious/depressed] do you feel right now?", "How [anxious/depressed] did you feel, on average, over the course of the day today?", "Felt little or no enjoyment in activities you usually enjoy", "worried"; BAI; BDI-II	Worry was concurrently associated with depressed mood; this was significant when both were entered as simultaneous predictors, suggesting independent associations with worry. Anhedonia was associated with worry and anxious mood, worry and anxious mood predicted anhedonia when entered simultaneously. Worry predicted later anhedonia and depressed mood, but anhedonia did not predict later anxious mood or later worry, suggesting that worrying could lead to anhedonia. Effect sizes: not available.	**Strengths:** Sample recruited from variety of sources all meeting same inclusion criteria; ecologically valid methods combined with structured clinical interview and standardised questionnaires; generalisable. **Limitations:** Measures of RT and Anhedonia limited to single item self-report questions, vulnerable to demand effects, although appropriate for the study design.	A - Strong B - Moderate C - N/A D - Moderate E - Strong F - Strong **OVERALL: Strong**
Takano, Sakamoto & Tanno (2014)	Experience sampling study looking at negative RNT, mood and sleep. Carried out over 1 week.	43 u/g participants, 33 females, mean age 19.4	CES-D; RNT measured on 3 dimensions – unpleasantness, self-focus & uncontrollability on 7-point Likert scales, NA (scared, afraid, upset) & PA (active, proud, strong) measured on 7-point Likert scales, indication of whether socially interacting at assessment points with family or friends,	Decreased PA in morning associated with increased level of RNT at the same time point, the high level of RNT persisted throughout afternoon and evening, but was not predicted later in the day by morning decrease in PA. Effect sizes: not available.	**Strengths:** Good ecological validity. **Limitations:** Indirect measure of anhedonia; limited generalisability due to u/g sample size.	A – Moderate B – Moderate C – N/A D – Moderate E – Strong F – Strong **OVERALL: Strong**

Author	Design and Aims	Sample	Measure	Main Findings relating to RT & Anhedonia, with Effect Sizes	Evaluation	QATQS ratings (see note for abbreviated ratings)
			Actigraphy used to measure daytime activity levels & night-time sleep parameters.			
			Experimental Studies			
Huffziger, Ebner-Priemer, Koudela, Reinhard, & Kuehner (2012)	Experimental experience sampling design looking at rumination induction (focus on ruminative statements for 3 mins on induction day vs. no induction day followed by 2nd rating of momentary rumination and mood) in daily life	40 participants from community sample, 20 females, mean age 22.7.	BDI-II; pre- and post- momentary ruminative self-focus measured by 2 questions "At the moment I am thinking about my [feelings/ problems]" rated on 8 point Likert scale; pre- and post-momentary mood measured by questions of valence (content-discontent & unwell-well) & calmness (agitated-calm & relaxed-tense) item scores range 0-6	Rumination induction significantly reduced momentary valence and calmness and these effects were not moderated by depressive symptoms. Participants showing higher increase in ruminative self-focus showed larger decrease in positive valence. Rumination induction was not found to affect ruminative self-focus or mood later in the day. Effect size: not available.	**Strengths:** Strong experimental design utilising laboratory rumination induction in daily life; good ecological validity; generalisable to wider population due to sample. **Limitations:** Indirect measure of anhedonia; only carried out at weekends, may not generalise to weekdays; fixed interval between testing points, may have been anticipated by participants, self-report measures vulnerable to demand effects.	A – Moderate B – Strong C – N/A D – Moderate E – Strong F – Strong **OVERALL: Strong**
Lyubomirsky & Nolen-Hoeksema (1993)	Study 1: Experimental design, manipulation of RNT using rumination vs. distraction task, then judgement of pleasant activities. Study 2: Experimental design, no manipulation, judgement of pleasant activities	Study 1: 73 psychology students, 41 females. 36 dysphoric group, 37 non-dysphoric group based on BDI-SF scores. Study 2: 130 psychology students, 69 females, 28 dysphoric group, 102 non-dysphoric group.	Study 1: Likert sadness and depression scales; judgement of 24 pleasant activities on Likert scales, "how much do you think you would enjoy this activity" (utility) and "how likely do you think that you would engage in this activity if you had the opportunity?" (likelihood). Study 2: judgement of pleasant activities as above.	Study 1: Dysphoric-ruminative group did not differ from dysphoric-distracting, nondysphoric-ruminative or nondysphoric-distracting groups on utility of activities. Dysphoric-ruminative group less likely to engage in pleasant activities than the other 3 groups. Dysphoric-ruminative group did not differ from dysphoric-distracting group on likelihood estimates (Effect size: d = 0.43). Dysphoric-ruminative group gave lower estimates of likelihood than nondysphoric-ruminative group (Effect size: d = 0.43) and nondysphoric-distracting group (Effect size: d = 0.76) Dysphoric-distracting group did not differ in likelihood estimates from nondysphoric-ruminative group (Effect size: d = 0.04) or	**Strengths:** Good sample sizes, control groups, proven rumination/ distraction task. **Limitations:** Self-report questionnaires to determine dysphoric/non-dysphoric groups, vulnerable to demand effects and recall bias, judgement of pleasant activities conceptual, thus lacks ecological validity.	A – Moderate B – Strong C – Strong D – Strong E – Strong F – Strong **OVERALL: Strong**

Author	Design and Aims	Sample	Measure	Main Findings relating to RT & Anhedonia, with Effect Sizes	Evaluation	QATQS ratings (see note for abbreviated ratings)
				nondysphoric-distracting group (Effect size: d = 0.45). Study 2: No differences found between dysphoric and non-dysphoric groups on utility or likelihood to engage in activities. Conclusion from Studies 1 and 2: dysphoric unwillingness to engage in distracting activities is due to rumination on depressed mood, not depressed mood alone.		
McLaughlin, Borkovec, & Sibrava (2007)	Experimental design induction of RNT (worry vs. Rumination counterbalanced) followed by assessment of NA, PA, relaxation, anxiety and depression.	Study 1: 60 u/g participants, 44 females. Study 2: 109 u/g participants from 3 trait groups (34 high worry & rumination, 40 high rumination, 35 control), 82 females, mean age 18.6	Study 1: BDI; PSWQ; MASQ; PANAS (state version); current feelings of depression, anxiety and relaxation measured on 5-point Likert scales. Study 2: As Study 1 with the inclusion of the RI.	Study 1: PA decreased from baseline to post-induction of worry and rumination, with no order effects. Effect size: η^2 = 0.28 Study 2: PA decreased from baseline to post-induction of worry and rumination. Effect size: η^2 = 0.22 Worry condition (worry induction prior to rumination induction): Significant effect of time, PA decreased from baseline to induction periods. Effect size: η^2 = 0.42 Within-subjects linear trend, indicating PA decreased from baseline to worry and decreased further from worry to rumination. Effect size: η^2 = 0.49 Rumination condition (rumination induction prior to worry induction): Significant effect of time, PA decreased from baseline to induction periods. Effect size: η^2 = 0.08 Within-subjects quadratic trend, indicating PA decreased from baseline to rumination and increased from rumination to worry. Effect size: η^2 = 0.14	**Strengths:** Good sample sizes across 2 studies; results replicated in study 2, standardised measures used; experimental design allows causal explanation. **Limitations:** Indirect measure of anhedonia; short periods of rumination or worry in comparison to wider literature, experimental design lacks ecological validity, self-report measures vulnerable to demand effects and recall bias.	A – Moderate B – Strong C – Strong D – Moderate E – Strong F – N/A **OVERALL: Strong**

Author	Design and Aims	Sample	Measure	Main Findings relating to RT & Anhedonia, with Effect Sizes	Evaluation	QATQS ratings (see note for abbreviated ratings)
Moberly & Watkins (2006).	Experimental design looking at whether the causal effects of processing mode on emotional regulation generalise to emotional vulnerability. Repeated focus on emotional scenarios, concrete vs. abstract prior to failure task.	54 female u/g participants, mean age 19.72 (7 male participants excluded from discussion of results).	PANAS; ACS-P; BDI	After failure, higher levels of trait RT were associated with lower levels of positive affect, but only in abstract condition, not in concrete condition. Effect size: $\Delta R^2 = .04$ ($f^2 = .08$)	**Strengths:** Experimental design allows causal explanation, good sample size, proven induction and standardised measures used. **Limitations:** Indirect measure of anhedonia; self-report measures, issues with generalisability due to all female sample, non-clinical u/g population, lacks ecological validity.	A – Moderate B – Strong C – Strong D – Strong E – Strong F – Strong **OVERALL: Strong**
Rood, Roelofs, Bögels, & Arntz (2012)	Experimental design looking at effects of rumination on affect in adolescents. RT induction while thinking about a stressful event - 4 conditions: rumination (RUM; N=40), acceptance (ACC; N=40), positive reappraisal (POS; N=41), distancing (DIS; N=39). Then affect measures.	160 non-clinical adolescent participants, 81 girls, mean age 14.45.	SRRS-C; CDI; VAS affect scales "gloomy", "sad", "happy"; Qualitative & Quantitative VAS manipulation check	Increase in PA was significantly stronger in POS in comparison to RUM (Effect size: d = 0.54), POS in comparison to DIS (Effect size: d = 0.8), and POS in comparison to ACC (Effect size: d = 0.5). Trait rumination did not moderate the effect of condition on PA.	**Strengths:** Large representative sample, standardised measures, experimental design allows causal explanation. **Limitations:** Indirect measure of anhedonia; manipulation was brief, lacks ecological validity, prompts may have elicited constructive forms of rumination	A – Moderate B – Strong C – Strong D – Moderate E – Strong F – N/A **OVERALL: Strong**
Watkins, Moberly, & Moulds (2008)	Experimental design, looking at the causal influence of processing mode on emotional responses to stress. Repeated focus on emotional scenarios, high construal (depressive rumination mode; DR) vs. Low construal (antithetical to depressive rumination	Study 3: 40 u/g participants, mean age 19.38, 28 females with minimal to moderate depressive symptoms, mean BDI 9.88. DR & A-DR conditions	Study 3: BDI-II; PANAS	Study 3: Decrease in PA from pre-stress to post-stress, significantly greater decrease in DR condition as compared to A-DR condition. Effect size (calculated): d = 0.35	**Strengths:** Experimental design, proven induction and standardised measures used. **Limitations:** Indirect measure of anhedonia, lacks ecological validity, failure induction relatively mild, predominantly female, non-clinical, u/g sample.	A – Moderate B – Strong C – Strong D – Strong E – Strong F – N/A **OVERALL: Strong**

Author	Design and Aims	Sample	Measure	Main Findings relating to RT & Anhedonia, with Effect Sizes	Evaluation	QATQS ratings (see note for abbreviated ratings)
	mode; A-DR) prior to failure task.					
Whitmer, Frank, & Gotlib (2012)	Experimental design, manipulation of RT using rumination vs. distraction task, then probabilistic selection task measuring participants approach to reward probability and avoidance of punishment probability.	83 participants, 44 MDD, 39 healthy controls before completion of task. Analyses on 16 MDD-rumination, 15 MDD-distraction, 15 control-rumination, 15 control-distraction	SCID; BDI; Mood questionnaire: 9-point Likert scales for positive and negative affect.	MDD-ruminators were relatively more sensitive to reward than punishment probabilities in comparison to all other groups who were equally sensitive to reward and punishment probabilities. Effect size: η^2_p = .153	**Strengths:** Proven rumination/ distraction task, structured clinical interview and standardised questionnaires used. **Limitations:** Small sample per condition, probabilistic selection task lacks ecological validity, not generalisable outside laboratory.	A – Strong B – Strong C – Strong D – Moderate E – Strong F – Strong **OVERALL: Strong**

Note. QATQS ratings: A = Selection Bias, B = Study Design, C = Confounders, D = Blinding, E = Data Collection Method, F = Withdrawals and Dropouts, MDD = Major Depressive Disorder; DSM = Diagnostic and Statistical Manual of Mental Disorders; u/g = undergraduates; ZTPI = Zimbardo Time Perspective Inventory; TSWLS = Temporal Satisfaction With Life Survey; PANAS = Positive and Negative Affect Scale; SPWB = Scales of Psychological Well-Being- short version; PA = Positive Affect; NA = Negative Affect; CES-D = Centre for Epidemiologic Studies Depression Scale; Problem Orientation Scale; ECQ = Emotion Control Questionnaire; TAS-20 = Toronto Alexithymia Scale; DASS = Depression Anxiety Stress Scale; VAS = Visual Analogue Scale; RRS = Ruminative Response Scale; GAD = Generalised Anxiety Disorder; SCID = Structured Clinical Interview for DSM Disorders; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory (SF = Short Form); POS = PSWQ = Penn State Worry Questionnaire; MASQ = Mood and Anxiety Symptoms Questionnaire; RI = Ruminations Inventory; ACS=P = Action Control Scale – Pre-occupation; SRRS-C = Stress Reactive Rumination Scale for Children; CDI = Children's Depression Inventory; SAR = State Anxiety Rating; PQ = Performance Questionnaire; ADIS-IV = Anxiety Disorders Interview Schedule for DSM-IV disorders; SIAS = Social Interaction Anxiety Scale; APD-IPDE = Avoidant Personality Disorder section of International Personality Disorder Examination; SPS = Social Phobia Scale; BFNE = Brief Fear of Negative Evaluation Scale; TQ = Thought Questionnaire; NR = Negative Rumination

Critical Evaluation

Cross-Sectional Studies

The four cross-sectional studies identified found an association between increased levels of RNT and increased levels of anhedonia, with medium to large effect sizes (with the exception of 1 study with a small effect size; Zou & Abbott, 2012), as measured by direct (Nelson & Mazure, 1985; Tanimukai, Hirai, Adachi, & Kishi, 2014) and indirect (Sailer et al., 2014; Zou & Abbott, 2012) methods. Nelson and Mazure (1985) measured anhedonia via a diagnosis of melancholic depression, where anhedonia is one of the key features, but not the only criteria. Therefore, other aspects of melancholic depression could be implicated so this is not a pure measure of anhedonia, but provides convergent evidence that there is a relationship between RNT and anhedonia.

These studies have used a wide range of participants: clinically depressed individuals (Nelson & Mazure, 1985), socially anxious individuals in comparison to a control group (predominantly undergraduates; Zou & Abbott, 2012), cancer patients and family members of cancer patients (Tanimukai et al., 2014), and a community sample and undergraduates (Sailer et al., 2014), providing evidence of this relationship in a diverse range of people.

Sailer and colleagues (2014) used the Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999), which is a trait measure of whether people tend to place themselves in the present, past or future and whether this perspective tends to be positive or negative. Although it is not a standardised measure of RNT, the past negative scale “embodies a pessimistic, negative or aversive attitude toward the past” (Zimbardo & Boyd, 1999, p. 1277), shares similarities with negative rumination, and is associated with depression, anxiety, unhappiness and low self-esteem

(Zimbardo & Boyd, 1999). Therefore, these findings should be treated with caution as it has not been examined in relation to RNT specifically.

A common limitation across these studies is the correlational design, which does not allow causal direction to be determined between RNT and anhedonia.

Longitudinal Studies

One study used standardised measures of RNT and PA in a prospective longitudinal design and found that RNT at time 1 predicted lower levels of PA at time 2 one year later when controlling for PA at time 1, with a medium effect size (Ciarrochi & Scott, 2006). This study also found that RNT accounted for unique variance in PA more reliably than ineffective problem solving and difficulty identifying emotions (Ciarrochi & Scott, 2006). The prospective longitudinal design allows one to examine temporal precedence and, thereby, to determine whether RNT precedes a decrease in PA.

Four experience sampling and daily diary studies found that increased RNT predicted increased anhedonia, with small to medium effect sizes, measured directly (Killingsworth & Gilbert, 2010; Starr & Davila, 2012) and indirectly via PA (Brans, Koval, Verduyn, Lin Lim, & Kuppens, 2013; Pasyugina, Koval, De Leersnyder, Mesquita, & Kuppens, 2014). One found that decreased PA predicted increased RNT (Takano, Sakamoto, & Tanno, 2014). Takano and Colleagues (2014) also found that low PA in the morning was indirectly related to higher levels of RNT in the evening.

The experience sampling or daily diary study method has good ecological validity due to the ability to directly and immediately assess RNT and its effect on momentary anhedonia or PA, thus reducing recall bias (Myin-Germeys et al., 2009). However, the reliance on self-report measures makes this approach potentially

vulnerable to demand effects. As single item questions were asked to determine RNT, anhedonia, or PA, these studies may not have captured the complexity that some of the standardised measures do, although this brief measurement enabled repeated assessment across time and situations, improving the ecological validity of the measures. Excessive diary length can reduce compliance (Morren, Dulmen, Ouwerkerk, & Bensing, 2009); therefore single item questions are necessary for a good compliance level.

The pattern of results across these longitudinal studies confirms the findings of the cross-sectional studies that there is a relationship between increased levels of RNT and anhedonia. Specifically, that increased RNT predicts an increase in anhedonia and in one case that PA predicted an increase in RNT. Although undergraduates were used in the majority of these studies, there are also large samples from the general population (Killingsworth & Gilbert, 2010) and those meeting criteria for generalised anxiety disorder (GAD; Starr & Davila), allowing a good level of generalisability of the findings. Furthermore the strong methodology of experiencing sampling and daily diary studies strengthens these findings.

Experimental Studies

The standardised experimental induction for rumination involves instructing participants to focus for eight minutes on sentences that involve rumination about themselves, their current feelings and their physical state, and the causes and consequences of their feelings (Nolen-Hoeksema & Morrow, 1993). As a control condition, a distraction induction is normally used where participants are instructed to focus for eight minutes on sentences that involve imagining visual scenes that do not relate to the self or current feelings. The general pattern of findings are that rumination exacerbates pre-existing negative mood and cognition relative to

distraction but only in individuals already in a dysphoric mood (e.g., Nolen-Hoeksema & Morrow, 1993). Lyubomirsky and Nolen-Hoeksema (1993) used this induction paradigm prior to judgements of pleasant activities in dysphoric and non-dysphoric participants. They found that dysphoric-ruminators reported that they were less likely to engage in pleasant activities than dysphoric-distracters and non-dysphoric-distracters and ruminators, with a medium effect size, but did not differ on their ratings of utility, i.e., how much they thought they would enjoy the activities (Lyubomirsky & Nolen-Hoeksema, 1993). This finding was replicated over two studies. A limitation of this study is that there were no behavioural components regarding actual engagement in activities with ratings of pleasure in these activities and thus it does not directly measure anhedonia. Participants' judgement of whether they would engage in or enjoy the activities may differ from their actual behaviour and resulting affect.

Whitmer, Frank and Gotlib (2012) used the same rumination induction paradigm followed by a probabilistic selection task designed to measure approach to reward and avoidance of punishment in depressed and non-depressed participants. In an initial training phase, participants learn the probability that different stimuli will be associated with reward and punishment. In a subsequent test phase where no feedback is provided, participants who are sensitive to the reward probabilities of the stimuli will select or approach the stimuli most rewarded in the training phase and participants who are sensitive to punishment probabilities will avoid or not select the stimuli most punished in the training phase (Whitmer, et al., 2012). They found that depressed-ruminators had an increased sensitivity to reward and decreased sensitivity to punishment in comparison to depressed-distracters and non-depressed-ruminators and distracters, with a large effect size (Whitmer et al., 2012).

Behavioural assessment of reward probability potentially provides a behavioural index related to anhedonia. However, this study confounded reward and punishment sensitivity and may be measuring the difference between these constructs and not anhedonia.

Moberly and Watkins (2006) trained participants to repeatedly think about positive and negative emotional scenarios in either a concrete or abstract way prior to an unanticipated failure task. The abstract condition was designed to provide an experimental analogue to naturally occurring depressive rumination, which is characterised by abstract thinking about the causes, meanings, and consequences of depression. The concrete condition was designed to be antithetical to depressive rumination. Previous studies had indicated that these different styles of processing during RT had distinct effects, with concrete processing more beneficial (Watkins, 2004; Watkins & Moulds, 2005). Moberly and Watkins (2006) found that higher levels of trait preoccupation were significantly correlated with decreased PA after the failure task for participants in the abstract RT condition, relative to participants in the concrete RT condition, with a small to medium effect size.

Watkins, Moberly and Moulds (2008) trained participants to think in an abstract depressive rumination (DR) mode versus a concrete antithetical-to-depressive rumination (A-DR) mode by asking them to read scenarios whose final sentence remained ambiguous until the final word – participants then completed a word fragment that disambiguated the scenario in either an abstract or concrete way. Participants then completed an unanticipated failure task. They found that PA decreased after the failure task and that PA decreased significantly more for participants in the DR mode condition in comparison to participants in the A-DR mode condition, with a small to medium effect size (Watkins et al., 2008). Moberly

and Watkins (2006) and Watkins and colleagues (2008) both measure PA after a failure task. This is a major limitation when considering anhedonia, which is traditionally viewed as a loss of pleasure in response to usually pleasurable activities. A reduction in PA after a failure task, which is not a pleasurable experience, does not measure anhedonia directly, but rather it measures the loss of pleasure in response to a negative experience; therefore the findings from these studies should be treated with caution.

McLaughlin, Borkovec and Sibrava (2007) examined the effects of periods of instructed worry and rumination within subjects (with order of RNT counterbalanced, i.e., worry then rumination versus rumination then worry). Neither study included a no-intervention or distraction control condition. Across both studies, worry and rumination were found to decrease PA, with a large effect size; when rumination occurred first, PA decreased, but then increased after worry; when worry occurred first, PA decreased after worry and then decreased further after rumination.

Rood and colleagues (2012) investigated RT and affect using a non-clinical sample of adolescents. They first primed participants to think about a recent stressful event and then instructed them to think about this event using different coping strategies (conditions: rumination, positive reappraisal, acceptance and distancing), measuring PA at baseline, after the stress induction and again after the coping strategy. They found that positive reappraisal was significantly more effective at increasing PA after the stress induction than rumination, acceptance, and distancing, with a medium effect size.

Because these experimental studies predominantly used undergraduate participants, their generalisability is limited as university undergraduates are not representative of the general population (Henrich, Heine, & Norenzayan, 2010).

Furthermore the nature of the experimental designs used lack ecological validity, firstly, as they were carried out in laboratory settings. Secondly, as inducing RNT experimentally and voluntarily to instructions may not reflect naturally occurring RNT, which typically occurs automatically in response to loss or difficulties (Nolen-Hoeksema, 1991). One study addresses the first issue to improve ecological validity by using an experimental experiencing sampling method in a community sample (Huffziger, Ebner-Priemer, Koudela, Reinhard, & Kuehner, 2012). In this study at each assessment point participants rated momentary mood and rumination followed by a 3 minute rumination induction (adapted from Nolen-Hoeksema & Morrow, 1993), and then rated momentary mood and rumination again. They found that rumination inductions increased momentary RNT and decreased PA and that higher increases in RNT were related to larger decreases in PA (Huffziger et al., 2012). Although this study still lacks ecological validity as inducing RNT is not equal to naturally occurring RNT, it is a strong methodology which controls for ecological validity, i.e., in the real world, whilst manipulating RT allows for a stronger inference about causality.

A further limitation of these experimental studies is the lack of a no-intervention control condition. Without a no-intervention control condition, it is hard to determine whether the relative difference between rumination and distraction is an active effect of RNT reducing PA or of distraction increasing PA or of both. However, it is difficult to establish an appropriate no-intervention control condition, especially as conditions in which participants are not asked to do anything for a period of time could involve spontaneous RNT.

There is preliminary evidence across the majority of these experimental studies that RNT causally contributes to anhedonia, as measured by direct and

indirect methods. The one exception to this finding (Whitmer et al., 2012) may not be measuring anhedonia. This evidence further strengthens the pattern of findings outlined from the cross-sectional and longitudinal studies.

Discussion

There is a growing, albeit small, body of literature on the relationship between RNT and direct and indirect measures of anhedonia. Eleven of the 17 articles reviewed here have been published in the last 5 years showing that there is increasing interest in this area. The first question asked for this review (Is there a relationship between RNT and anhedonia?) has been answered. The correlational and longitudinal studies found that increased RNT is associated with increases in direct and indirect measures of anhedonia, with effect sizes ranging from small to large (Brans et al., 2013; Ciarrochi & Scott, 2006; Killingsworth & Gilbert, 2010; Nelson & Mazure, 1985; Pasyugina et al., 2014; Sailer et al., 2014; Starr & Davila, 2012; Takano et al., 2014; Tanimukai et al., 2014, Zou & Abbott, 2012). However, the correlational nature of these designs leaves unresolved whether RNT causally contributes to anhedonia, or whether anhedonia increases RNT, or whether anhedonia and RNT share a common third factor.

The experimental studies provide preliminary evidence that RNT causally contributes to anhedonia, especially on measures of PA, with effect sizes ranging from small to large (Huffziger et al., 2012; Lyubomirsky & Nolen-Hoeksema, 1993; McLaughlin et al., 2007; Moberly & Watkins, 2006; Rood et al., 2012; Watkins et al., 2008). One study identified a different pattern of findings which could imply that RNT caused a decrease in anhedonia (Whitmer et al., 2012), but the experimental task may not have been measuring this construct.

One important factor is that very few studies included a behavioural component of anhedonia or PA in response to usually pleasurable activities, with the majority relying on self-report measures of changes in PA alone. This is a major limitation in the research as although PA is associated with anhedonia and both are associated with the behavioural activation system, it does not directly measure anhedonia, i.e., loss of enjoyment or pleasure in the context of usually pleasurable activities. A further limitation in the experimental studies is that two studies (Moberly & Watkins, 2006; Watkins et al., 2008) measured PA after a failure task. A reduction in PA after a stressful experience measures loss of pleasure in response to a negative experience, rather than loss of pleasure in response to usually pleasurable experiences, therefore these studies do not measure anhedonia according to the traditional conceptual view of anhedonia. These studies were included in the review as they met the search criteria, but their findings should be read with caution. Similarly it could be argued that measuring PA following a RNT induction (which is also a stressful experience; Huffziger et al., 2012; McLaughlin et al., 2007; Rood et al., 2012) again does not assess anhedonia.

In addition, the majority of the studies reviewed use measures of consummatory anhedonia, i.e., they measure how participants are feeling in the moment and not their motivational or anticipatory anhedonia, or they measure PA, with the exception of Lyubomirsky and Nolen-Hoeksema (1993), who also measure anticipatory anhedonia, but as a prediction of likelihood to engage, rather than actual engagement in activities. Therefore whether there is a relationship between RNT and anticipatory anhedonia has not been addressed in the current literature. Although there has been limited empirical study of consummatory and anticipatory anhedonia, Sherdell and colleagues (2012) found that anticipatory anhedonia

significantly predicted motivation in a negative direction within depressed participants, whereas consummatory anhedonia did not differ between depressed participants and controls. Thus it could be that if the relationship between anticipatory anhedonia and RNT was investigated a stronger relationship may be found than for consummatory anhedonia.

Therefore, future research should focus on more direct assessment of anhedonia in relation to RNT and include measures of anticipatory anhedonia as well as consummatory anhedonia. In addition, further experimental studies which include a behavioural measure of anhedonia (e.g., probabilistic reward task; Pizzagalli et al., 2005) would enable exploration of whether there is a causal relationship between RNT and anhedonia. Furthermore, experimental studies which look at the mechanism by which this relationship occurs would be of use, for example studies that examine whether focus of attention is a mediator of the relationship between RNT and anhedonia as hypothesised (e.g., Watkins, 2013).

This review provides preliminary evidence that there is a relationship between RNT and anhedonia (primarily consummatory anhedonia) and indicates that this could be a causal relationship. These findings provide preliminary support for the hypothesis that RNT leads to reduced engagement in the external environment and thus contributes to anhedonia (Stein et al., 2009; Watkins, 2008, 2011, 2013), but further research to determine the nature of the relationship using experimental methods and specific measures of anhedonia is warranted.

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Appendices

Appendix A: Quality Assessment Tool for Quantitative Studies

COMPONENT RATINGS

A) SELECTION BIAS

(Q1) Are the individuals selected to participate in the study likely to be representative of the target population?

Very likely
Somewhat likely
Not likely
Can't tell

(Q2) What percentage of selected individuals agreed to participate?

80 - 100% agreement
60 – 79% agreement
less than 60% agreement
Not applicable
Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

B) STUDY DESIGN

Indicate the study design

Randomized controlled trial
Controlled clinical trial
Cohort analytic (two group pre + post)
Case-control
Cohort (one group pre + post (before and after))
Interrupted time series
Other specify _____
Can't tell

Was the study described as randomized? If NO, go to Component C.

No Yes

If Yes, was the method of randomization described? (See dictionary)

No Yes

If Yes, was the method appropriate? (See dictionary)

No Yes

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

C) CONFOUNDERS

(Q1) Were there important differences between groups prior to the intervention?

Yes
No
Can't tell

The following are examples of confounders:

Race
Sex
Marital status/family
Age
SES (income or class)
Education
Health status
Pre-intervention score on outcome measure

(Q2) If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?

80 – 100% (most)
60 – 79% (some)
Less than 60% (few or none)
Can't Tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

D) BLINDING

(Q1) Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?
Yes
No
Can't tell

(Q2) Were the study participants aware of the research question?
Yes
No
Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

E) DATA COLLECTION METHODS

(Q1) Were data collection tools shown to be valid?
Yes
No
Can't tell

(Q2) Were data collection tools shown to be reliable?
Yes
No
Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

F) WITHDRAWALS AND DROP-OUTS

(Q1) Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?
Yes
No
Can't tell
Not Applicable (i.e. one time surveys or interviews)

(Q2) Indicate the percentage of participants completing the study. (If the percentage differs by groups, record the lowest).
80 -100%
60 - 79%
less than 60%
Can't tell
Not Applicable (i.e. Retrospective case-control)

RATE THIS SECTION	STRONG	MODERATE	WEAK	
See dictionary	1	2	3	Not Applicable

G) INTERVENTION INTEGRITY

(Q1) What percentage of participants received the allocated intervention or exposure of interest?
80 -100%

60 - 79%
less than 60%
Can't tell

(Q2) Was the consistency of the intervention measured?
Yes
No
Can't tell

(Q3) Is it likely that subjects received an unintended intervention (contamination or co-intervention) that may influence the results?
Yes
No
Can't tell

H) ANALYSES

(Q1) Are the statistical methods appropriate for the study design?
Yes
No
Can't tell

GLOBAL RATING
COMPONENT RATINGS

Please transcribe the information from the gray boxes on pages 1-4 onto this page. See dictionary on how to rate this section.

A	**SELECTION BIAS**	**STRONG**	**MODERATE**	**WEAK**	
		1	**2**	**3**	
B	**STUDY DESIGN**	**STRONG**	**MODERATE**	**WEAK**	
		1	**2**	**3**	
C	**CONFOUNDERS**	**STRONG**	**MODERATE**	**WEAK**	
		1	**2**	**3**	
D	**BLINDING**	**STRONG**	**MODERATE**	**WEAK**	
		1	**2**	**3**	
E	**DATA COLLECTION METHOD**	**STRONG**	**MODERATE**	**WEAK**	
		1	**2**	**3**	
F	**WITHDRAWALS AND DROPOUTS**	**STRONG**	**MODERATE**	**WEAK**	
		1	**2**	**3**	**Not Applicable**

GLOBAL RATING FOR THIS PAPER (circle one):
1 STRONG (no WEAK ratings)
2 MODERATE (one WEAK rating)
3 WEAK (two or more WEAK ratings)
With both reviewers discussing the ratings:
Is there a discrepancy between the two reviewers with respect to the component (A-F) ratings?
No Yes
If yes, indicate the reason for the discrepancy
1 Oversight
2 Differences in interpretation of criteria
3 Differences in interpretation of study
Final decision of both reviewers (circle one):
1 STRONG
2 MODERATE
3 WEAK

Appendix B: Quality Assessment Tool for Quantitative Studies Dictionary

The purpose of this dictionary is to describe items in the tool thereby assisting raters to score study quality. Due to under-reporting or lack of clarity in the primary study, raters will need to make judgements about the extent that bias may be present. When making judgements about each component, raters should form their opinion based upon information contained in the study rather than making inferences about what the authors intended.

A) SELECTION BIAS

(Q1) Participants are more likely to be representative of the target population if they are randomly selected from a comprehensive list of individuals in the target population (score very likely). They may not be representative if they are referred from a source (e.g. clinic) in a systematic manner (score somewhat likely) or self-referred (score not likely).

(Q2) Refers to the % of subjects in the control and intervention groups that agreed to participate in the study before they were assigned to intervention or control groups.

B) STUDY DESIGN

In this section, raters assess the likelihood of bias due to the allocation process in an experimental study. For observational studies, raters assess the extent that assessments of exposure and outcome are likely to be independent. Generally, the type of design is a good indicator of the extent of bias. In stronger designs, an equivalent control group is present and the allocation process is such that the investigators are unable to predict the sequence.

Randomized Controlled Trial (RCT)

An experimental design where investigators randomly allocate eligible people to an intervention or control group. A rater should describe a study as an RCT if the randomization sequence allows each study participant to have the same chance of receiving each intervention and the investigators could not predict which intervention was next. If the investigators do not describe the allocation process and only use the words ‘random’ or ‘randomly’, the study is described as a controlled clinical trial.

See below for more details.

Was the study described as randomized?

- Score YES, if the authors used words such as random allocation, randomly assigned, and random assignment.
- Score NO, if no mention of randomization is made.

Was the method of randomization described?

- Score YES, if the authors describe any method used to generate a random allocation sequence.
- Score NO, if the authors do not describe the allocation method or describe methods of allocation such as alternation, case record numbers, dates of birth, day of the week, and any allocation procedure that is entirely transparent before assignment, such as an open list of random numbers of assignments.
- If NO is scored, then the study is a controlled clinical trial.

Was the method appropriate?

- Score YES, if the randomization sequence allowed each study participant to have the same chance of receiving each intervention and the investigators could not predict which intervention was next. Examples of appropriate approaches include assignment of subjects by a central office unaware of subject characteristics, or sequentially numbered, sealed, opaque envelopes.
- Score NO, if the randomization sequence is open to the individuals responsible for recruiting and allocating participants or providing the intervention, since those individuals can influence the allocation process, either knowingly or unknowingly.
- If NO is scored, then the study is a controlled clinical trial.

Controlled Clinical Trial (CCT)

An experimental study design where the method of allocating study subjects to intervention or control groups is open to individuals responsible for recruiting subjects or providing the intervention. The method of allocation is transparent before assignment, e.g. an open list of random numbers or allocation by date of birth, etc.

Cohort analytic (two group pre and post)

An observational study design where groups are assembled according to whether or not exposure to the intervention has occurred. Exposure to the intervention is not under the control of the investigators. Study groups might be non-equivalent or not comparable on some feature that affects outcome.

Case control study

A retrospective study design where the investigators gather ‘cases’ of people who already have the outcome of interest and ‘controls’ who do not. Both groups are then questioned or their records examined about whether they received the intervention exposure of interest.

Cohort (one group pre + post (before and after)

The same group is pretested, given an intervention, and tested immediately after the intervention. The intervention group, by means of the pretest, act as their own control group.

Interrupted time series

A time series consists of multiple observations over time. Observations can be on the same units (e.g. individuals over time) or on different but similar units (e.g. student achievement scores for particular grade and school). Interrupted time series analysis requires knowing the specific point in the series when an intervention occurred.

C) CONFOUNDERS

By definition, a confounder is a variable that is associated with the intervention or exposure and causally related to the outcome of interest. Even in a robust study design, groups may not be balanced with respect to important variables prior to the intervention. The authors should indicate if confounders were controlled in the design (by stratification or matching) or in the analysis. If the allocation to intervention and control groups is randomized, the authors must report that the groups were balanced at baseline with respect to confounders (either in the text or a table).

D) BLINDING

(Q1) Assessors should be described as blinded to which participants were in the control and intervention groups. The purpose of blinding the outcome assessors (who might also be the care providers) is to protect against detection bias.

(Q2) Study participants should not be aware of (i.e. blinded to) the research question. The purpose of blinding the participants is to protect against reporting bias.

E) DATA COLLECTION METHODS

Tools for primary outcome measures must be described as reliable and valid. If 'face' validity or 'content' validity has been demonstrated, this is acceptable. Some sources from which data may be collected are described below:

Self reported data includes data that is collected from participants in the study (e.g. completing a questionnaire, survey, answering questions during an interview, etc.).

Assessment/Screening includes objective data that is retrieved by the researchers. (e.g. observations by investigators).

Medical Records/Vital Statistics refers to the types of formal records used for the extraction of the data.

Reliability and validity can be reported in the study or in a separate study. For example, some standard assessment tools have known reliability and validity.

F) WITHDRAWALS AND DROP-OUTS

- Score YES if the authors describe BOTH the numbers and reasons for withdrawals and drop-outs.
- Score NO if either the numbers or reasons for withdrawals and drop-outs are not reported.

The percentage of participants completing the study refers to the % of subjects remaining in the study at the final data collection period in all groups (i.e. control and intervention groups).

G) INTERVENTION INTEGRITY

The number of participants receiving the intended intervention should be noted (consider both frequency and intensity). For example, the authors may have reported that at least 80 percent of the participants received the complete intervention. The authors should describe a method of measuring if the intervention was provided to all participants the same way. As well, the authors should indicate if subjects received an unintended intervention that may have influenced the outcomes. For example, co-intervention occurs when the study group receives an additional intervention (other than that intended). In this case, it is possible that the effect of the intervention may be over-estimated. Contamination refers to situations where the control group accidentally receives the study intervention. This could result in an under-estimation of the impact of the intervention.

H) ANALYSIS APPROPRIATE TO QUESTION

Was the quantitative analysis appropriate to the research question being asked?

An intention-to-treat analysis is one in which all the participants in a trial are analyzed according to the intervention to which they were allocated, whether they received it or not. Intention-to-treat analyses are favoured in assessments of effectiveness as they mirror the noncompliance and treatment changes that are likely

to occur when the intervention is used in practice, and because of the risk of attrition bias when participants are excluded from the analysis.

Component Ratings of Study:

For each of the six components A – F, use the following descriptions as a roadmap.

A)SELECTION BIAS

Strong: The selected individuals are very likely to be representative of the target population (Q1 is 1) and there is greater than 80% participation (Q2 is 1).

Moderate: The selected individuals are at least somewhat likely to be representative of the target population (Q1 is 1 or 2); and there is 60 - 79% participation (Q2 is 2). 'Moderate' may also be assigned if Q1 is 1 or 2 and Q2 is 5 (can't tell).

Weak: The selected individuals are not likely to be representative of the target population (Q1 is 3); or there is less than 60% participation (Q2 is 3) or selection is not described (Q1 is 4); and the level of participation is not described (Q2 is 5).

B) DESIGN

Strong: will be assigned to those articles that described RCTs and CCTs.

Moderate: will be assigned to those that described a cohort analytic study, a case control study, a cohort design, or an interrupted time series.

Weak: will be assigned to those that used any other method or did not state the method used.

C) CONFOUNDERS

Strong: will be assigned to those articles that controlled for at least 80% of relevant confounders (Q1 is 2); or (Q2 is 1).

Moderate: will be given to those studies that controlled for 60 – 79% of relevant confounders (Q1 is 1) and (Q2 is 2).

Weak: will be assigned when less than 60% of relevant confounders were controlled (Q1 is 1) and (Q2 is 3) or control of confounders was not described (Q1 is 3) and (Q2 is 4).

D) BLINDING

Strong: The outcome assessor is not aware of the intervention status of participants (Q1 is 2); and the study participants are not aware of the research question (Q2 is 2).

Moderate: The outcome assessor is not aware of the intervention status of participants (Q1 is 2); or the study participants are not aware of the research question (Q2 is 2); or blinding is not described (Q1 is 3 and Q2 is 3).

Weak: The outcome assessor is aware of the intervention status of participants (Q1 is 1); and the study participants are aware of the research question (Q2 is 1).

E) DATA COLLECTION METHODS

Strong: The data collection tools have been shown to be valid (Q1 is 1); and the data collection tools have been shown to be reliable (Q2 is 1).

Moderate: The data collection tools have been shown to be valid (Q1 is 1); and the data collection tools have not been shown to be reliable (Q2 is 2) or reliability is not described (Q2 is 3).

Weak: The data collection tools have not been shown to be valid (Q1 is 2) or both reliability and validity are not described (Q1 is 3 and Q2 is 3).

F) WITHDRAWALS AND DROP-OUTS

Strong: will be assigned when the follow-up rate is 80% or greater (Q2 is 1).

Moderate: will be assigned when the follow-up rate is 60 – 79% (Q2 is 2) OR Q2 is 5 (N/A).

Weak: will be assigned when a follow-up rate is less than 60% (Q2 is 3) or if the withdrawals and drop-outs were not described (Q2 is 4).

Appendix C: Author Guidelines

Journal of Experimental Psychopathology
Guidelines for Authors
Scope of the Journal

The ***Journal of Experimental Psychopathology*** is an e-journal created to publish cutting-edge original contributions to scientific knowledge in the general area of psychopathology. Although there will be an emphasis on publishing research which has adopted an experimental approach to describing and understanding psychopathology, the journal will also welcome submissions that make significant contributions to knowledge using other empirical methods such as correlational designs, meta-analyses, epidemiological and prospective approaches, and single-case experiments. Theoretical and review articles addressing significant issues in the description, aetiology, and treatment of psychopathologies are also welcome.

The Editors and Associate Editors will make an initial determination of whether or not submissions fall within the scope of the journal and are of sufficient merit and importance to warrant full review.

Submitting Manuscripts

Authors should submit their manuscript electronically via the journal's editorial system (http//jep.textrum.com/). Your manuscript will then be allocated to an Associate Editor who will manage the peer review process. You should retain an editable version of your paper in WORD or similar format because this may be needed for further processing should your manuscript be accepted for publication.

There is no word-limit to articles that may be accepted for publication, but the Editors would expect presentation to be efficient, concise and informative. Most articles accepted for publication would usually be no more than 50 manuscript pages.

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the Editors.

Presentation of the Manuscript

The manuscript should follow American Psychological Association (APA) publication manual guidelines. All pages should be typed double-spaced and numbered (including pages containing the title, authors names and affiliation footnotes, abstract, acknowledgments, references, tables, and figure caption list).

Title Page: A title page should be provided and should include the full title of the article, the authors' names and affiliations, and a suggested running head. The affiliation should include the department, institution, city or town, and country. It should be made clear in which institution(s) the research was carried out. The

suggested running head should be no more than 80 characters. The title page should also clearly indicate the name, address, email address, fax number and telephone number of the corresponding author.

Abstract: An abstract following American Psychological Association guidelines should be provided and preferably be no longer than 150 words. The abstract page should also provide a list of 5-10 key words that accurately reflect the content of the article and can be used for indexing and search purposes.

Format of the article**:** Divide your article into clearly defined sections with the use of headings (non-numbered). The following headings are mandatory: Abstract, Introduction, Method, Participants, Procedure, Results, Discussion and References, but authors may include other headings where appropriate. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

Figures & Illustrations: Photographs, drawings, diagrams, graphs and charts should be numbered in one consecutive series of Arabic numerals. Each individual figure or illustration should be accompanied by a clearly-worded caption or figure legend. All figures, tables, photographs, drawings, charts and diagrams should be submitted within the manuscript, preferably on separate pages at the end of the manuscript. If your manuscript is accepted for publication you may then be asked to submit your artwork in an electronic format and supply high-quality printouts in case conversion of the electronic artwork is problematic.

Tables: Tables should be numbered in one consecutive series of Arabic numerals. Each table should be typed on a separate page with the title centred above the table and all explanatory footnotes, etc. printed below.

Acknowledgements: Do not include acknowledgements on the title page. Place them on a separate page after the main body of the article and before the reference list.

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BOOKS
Davey G.C.L. & Wells A. (Eds) (2006) *Worry and its psychological disorders: Theory, assessment and treatment*. Chichester: John Wiley.

BOOK CHAPTERS
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SCHOOL OF PSYCHOLOGY

DOCTORATE IN CLINICAL PSYCHOLOGY

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Repetitive Negative Thought and Reward Sensitivity

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Abstract

It is hypothesised that repetitive negative thought (RNT) causally contributes to anhedonia. There is cross-sectional and longitudinal evidence of this relationship, but it has not previously been investigated directly using experimental methods. In the present study, student participants were randomly assigned to an unresolved goal (RNT) manipulation (n = 43) or resolved goal (control) manipulation (n =41) prior to completing a reward sensitivity task. This task has been reliably found to train a response bias towards the stimuli that is differentially positively reinforced, with both depression and self-reported anhedonia associated with a reduced response bias. The unresolved goal versus resolved goal manipulation was effective, with the unresolved condition producing significantly higher levels of RNT during the reward sensitivity task relative to the resolved condition. Inconsistent with study predictions, there was no significant difference between the conditions on response bias, although there were trend findings, which tentatively suggest that RNT may influence anhedonia. Potential accounts for the null findings and future research are discussed.

Keywords

Anhedonia; Repetitive Negative Thought; Rumination; Worry; Reward Sensitivity; Probabilistic Reward Task; Response Bias

Introduction

The Diagnostic and Statistical Manual for Mental Disorders (DSM-IV-TR; American Psychiatric Association [APA], 2000) defines anhedonia as reduced ability to be rewarding of stimuli that have previously been found to be rewarding, i.e., a diminished interest or pleasure in response to stimuli that were previously perceived as rewarding during a pre-morbid state. It is a core symptom of depression (APA, 2000) and it is estimated that 37% of individuals with a diagnosis of depression experience anhedonia (Pelizza & Ferrari, 2009). It is also considered a risk factor increasing vulnerability to depression (Costello, 1972; Meehl, 1975).

Reward contains multiple psychological components : (a) the affective consequences of rewards, i.e., “liking”, related to satiation and in-the-moment pleasure (Berridge & Robinson, 1998, 2003); (b) the motivational consequences of rewards, i.e., “wanting”, in which incentive salience increases with increased goal-directed activity targeting desired outcomes e.g., craving (Berridge & Robinson, 1998, 2003); and (c) the ability to learn about relationships among stimuli and the consequences of actions, including classical (Stimulus-Stimulus predictive reward associations, Stimulus-Response associations) and instrumental conditioning (response-contingent reinforcement; Berridge & Robinson, 2003). The affective and motivational consequences of rewards are dissociable because “wanting” can be manipulated without changing “liking” (Berridge & Robinson, 2003).

In turn, the distinction between “liking” and “wanting” in the non-clinical literature broadly maps onto the distinction between deficits in the hedonic response to rewards (“consummatory anhedonia”, i.e., not enjoying receiving

previously rewarding stimuli) and a diminished motivation or drive to pursue them ("motivational anhedonia" – with an anticipatory component; Treadway & Zald, 2011).

It has been hypothesized that motivational impairments in Major Depressive Disorder (MDD) arise from deficits in processing related primarily to "wanting" and anticipatory pleasure rather than to "liking" and consummatory pleasure (Dichter, 2010); although there has been limited empirical testing of "wanting" vs. "liking" in depressed patients. For example on "sweet taste test" paradigms in which participants rate the pleasantness of different sucrose concentrations, no differences in reported hedonic impact are found between patients with depression and matched controls (Amsterdam, Settle, Doty, Abelman, & Winokur, 1987). Using decks of humorous versus non-humorous cartoons, Sherdell, Waugh, and Gotlib (2012) used an effort measurement task (number of clicks required on a computer square to receive a cartoon) and self-report ratings to investigate preference, "liking" and "wanting" for rewarding stimuli in depressed patients versus controls. Anticipatory anhedonia significantly predicted motivation (effort) in a negative direction within the depressed patients. MDD and control participants did not differ in their consummatory response to reward.

The role of learning in anhedonia could involve reward-related deficits including impaired reward learning and reinforcement conditioning. Reinforcement paradigms to explore anhedonia have found that individuals with depression fail to develop a response bias towards rewarded stimuli (Henriques, Glowacki, & Davidson, 1994; Pizzagalli, Iosifescu, Hallett, Ratner, & Fava, 2009; Pizzagalli, Jahn, & O'Shea, 2005), providing strong evidence

for an insensitivity to reward-relevant information in MDD. Additionally, using a signal detection task with a differential reinforcement schedule, Pizzagalli and colleagues (2009) found that in comparison to controls, MDD participants only showed reduced reward sensitivity in trials following omission of reward for a correctly identified rich stimulus (more frequently rewarded) and were more likely to misidentify the more frequently rewarded stimulus following reward of the lean (less frequently rewarded) stimulus. They suggest that this indicates that depressed participants were able to respond to single rewards but were not able to integrate reinforcement history over time, thus showing a diminished capacity to modulate their behaviour as a function of reinforcement history (i.e., a reduction in reward learning; Pizzzagalli et al., 2009). It is not clear whether these reinforcement deficits are driven by reduced hedonic capacity, diminished motivation, or both or whether they reflect unrelated processes (i.e., impaired detection of information). Both “liking” and “wanting” are properties that can become associated with reward predicting cues through a process of Pavlovian conditioning.

Reduced reward responsiveness is an important dimension identified within anhedonia. It is defined as a reduced ability to learn which of several differentially rewarded stimuli was the most advantageous (Pizzagalli et al., 2009). Pizzagalli and colleagues (2009) hypothesised that patients with MDD have reduced responsiveness to reward, as assessed on a signal detection task using a differential reinforcement schedule. Poor performance, as measured by a reduction in reward sensitivity on this signal detection task, is associated with self-reported anhedonia (e.g., Pizzagalli, Jahn, & O’Shea, 2005). Using this task, studies have found that individuals with elevated

depressive symptoms (Pizzagalli et al., 2005) and with MDD (Pizzagalli et al., 2009) display reduced reward sensitivity. Stress has also been shown to have an impact on depressive symptoms, onset of depression, and anxiety and has been linked to anhedonia (Bogdan & Pizzagalli, 2006). Other studies using a signal detection task have found that stress (either the threat of shock or negative feedback) reduces reward sensitivity in a non-clinical sample (Bogdan & Pizzagalli, 2006) and participants reporting high levels of perceived stress (Pizzagalli, Bogdan, Ratner, & Jahn, 2007). Thus, this robust experimental research suggests that reduced reward responsiveness is an important component of anhedonia, which provides a reliable behavioural index of anhedonia.

The mechanisms underpinning anhedonia and reduced reward responsiveness in depression have not yet been fully delineated. Identifying mechanisms could lead to development of specific interventions designed to target them. One potential mechanism that has been hypothesised is repetitive negative thought (RNT; e.g., Watkins, 2013). RNT is a negatively focused form of repetitive thought, which is defined as “the process of thinking attentively, repetitively, or frequently about oneself and one’s world” (Segerstrom, Stanton, Alden, & Shortridge, 2003, p. 909). RNT is hypothesised to be a transdiagnostic process, which is present in a number of psychiatric diagnoses (e.g., depression, generalised anxiety disorder, social anxiety and post-traumatic stress disorder) and has a causal contribution to these diagnoses (Harvey, Watkins, Mansell, & Shafran, 2004; Ehring & Watkins, 2008; Watkins, 2013).

Depressive rumination and worry are characteristic of RNT (Segerstrom et al., 2003). Depressive rumination is defined as “behaviours and thoughts that focus one’s attention on one’s depressive symptoms and on the implications of these symptoms” (Nolen-Hoeksema, 1991, p. 569) and is a key construct in depression. Worry is defined as “a chain of thoughts and images, negatively affect-laden and relatively uncontrollable” (Borkovec, Robinson, Pruzinsky, & DePree, 1983, p. 10), and is conceptualised as an attempt to avoid negative outcomes through problem-solving and preparing for the worst. Worry is often linked to an increase in negative affect (anxiety and depression; Borkovec, Ray, & Stöber, 1998).

It is hypothesised that rumination and worry share the same underlying process and consequences (Segerstrom, Tsao, Alden, & Craske, 2000; Watkins 2008), with consistent evidence arising from a range of sources (e.g., Fresco, Frankel, Mennin, Turk, & Heimberg, 2002; Papageorgiou & Wells, 1999; Segerstrom et al., 2000; Watkins, 2004; Watkins, Moulds, & Mackintosh, 2005). One proposed difference between rumination and worry is that rumination is predominantly focused on the past and self-identity, whereas worry is focused on the future and threat (Watkins, 2013).

RNT is hypothesised to reduce responsiveness to information that does not relate to the content of RNT (Stein, Lehtonen, Harvey, Nicol-Harper, & Craske, 2009; Watkins, 2008, 2011); when processing information, selective attention allows the individual to process the most relevant information (Lehtonen et al., 2009). Empirical evidence has found that RNT impairs concentration (Lyubomirsky, Kasri, & Zehm, 2003) and central executive functioning, which is effortful and relies on access to limited

capacity cognitive processes (Watkins & Brown, 2002), in depressed participants, and attention in non-depressed participants (Roberts, Watkins, & Wills, 2013). Thus, if an individual is engaged in RNT, it is hypothesised that this preoccupation will reduce engagement in the external environment, unless the focus of the RNT is directly related to the environment, possibly via its effects on concentration, central executive functioning and attention. First, attention is on the content of the RNT at the expense of external information (rather than focusing "on the world", focusing "in the head"). Second, there may be increased abstract processing of the general implications of events, with reduced sensitivity to contextual and situational detail (Watkins, 2008). Lehtonen and colleagues (2009) found that inducing preoccupation in individuals prone to preoccupation reduced the processing of interpersonal information. In addition to this, Rottenberg, Gross and Gotlib (2005) suggested that rumination could account, in part, for the hypothesised phenomenon of Emotional Context Insensitivity (ECI), in which depressed individuals are observed to display reduced reactivity to all emotional cues, both positive and negative (Rottenberg, 2005; 2007). Individuals with major depression display reduced positive and negative emotional reactivity, and ECI appears to provide the best explanation for this pattern (Byslma, Morris, & Rottenberg, 2008).

Thus, RNT is implicated in reducing engagement with the external environment. As such, it has been hypothesised that RNT may contribute to anhedonia due to less contact with positive reinforcers and reduced awareness of positive contingency (Watkins, 2013). Consistent with this hypothesis, cross-sectional (e.g., Nelson & Mazure, 1985) and longitudinal

(e.g., Killingsworth & Gilbert, 2010) studies have found a positive association between RNT and anhedonia. In addition, there is preliminary evidence that RNT influences reduced positive affect, which is negatively correlated with anhedonia (e.g., Huffziger, Ebner-Priemer, Koudela, Reinhard, & Kuehner, 2012; Watkins, Moberly, & Moulds, 2008). However, anhedonia has not been directly assessed, thus, does RNT cause anhedonia or vice versa, or are both related to a third common factor? Recent theorists (Watkins, 2013) have proposed that RNT causally contributes to anhedonia. Therefore, to test this hypothesis, the current study experimentally manipulated state RNT and investigated its effect on a behavioural performance index of anhedonia – the signal detection task of reward responsiveness (henceforward the reward sensitivity task), previously demonstrated by Pizzagalli and colleagues (2005) to positively correlate with self-reported anhedonia.

RNT was manipulated using inductions that asked participants to focus on resolved goals versus unresolved goals, which have been found to differentially induce state RNT (Roberts et al., 2013). Roberts and colleagues (2013) found that this manipulation was efficacious and persisted throughout a subsequent cognitive task, and thus, it is expected to be sufficiently robust for the signal detection task. Because the effect of these manipulations on state RNT have been found to be moderated by trait RNT (Roberts et al., 2013), whether trait RNT moderated the relationship between state RNT and reward sensitivity was also investigated.

In the current study design, it was predicted that there would be a main effect of condition on the level of self-reported RNT during the signal detection task, as a manipulation check for the RNT induction. The main prediction was

that the unresolved goal condition would demonstrate less reward sensitivity relative to the resolved goal condition. It was also predicted that the main effect would be moderated by trait RNT, such that those with elevated trait RNT would have less reward sensitivity post manipulation in the unresolved goal condition.

Methods

Design

The study design was a between subjects experimental design with one independent variable (IV): resolved vs. unresolved goal condition in the RNT task. The dependent variable (DV) is the response bias in the reward sensitivity task. Participants were randomly allocated to each of the conditions.

Power Analysis

The current study investigated a novel question, which had not been previously studied in the literature. Therefore, there was no direct data on which to base a power calculation, and the power required was estimated by comparing the effect sizes from the most analogous studies. Roberts, Watkins and Wills (2013) using the resolved versus unresolved goal rumination task found an effect size of d = 0.87 between the conditions in the differential effect on the DV of state RT. Pizzagalli and colleagues (2009) found that participants with MDD in comparison to controls had a significantly lower response bias in the reward sensitivity task with an effect size of d = 0.6 (estimated from figure 2A). Therefore assuming there is a relationship between RNT and anhedonia, using the weaker of these effect sizes (d =0.6), power was estimated using Cohen's power tables (Cohen, 1988). For an

estimated effect size of *d* = 0.6, for a two-tailed test with *a* = 0.05, 40 participants per condition provides power = 0.75; 50 participants per condition provides power = 0.84, therefore 45 participants per condition would be required for power = 0.80[1].

Participants

The sample consisted of 91 students recruited from the University of Exeter who received course credit for participation. Participants were required to have normal or corrected to normal vision and be able to speak and read fluent English[2]. Participants would have been excluded if they were expressing suicidal ideation[3]. The study was approved by the University of Exeter Department of Psychology Ethics Committee (see appendix A). Eighty percent of the participants were undergraduates and 20% were Clinical Psychology postgraduates. The majority were female (84.6%), White British (73.6%) and right handed (92.3%). The age range was 18 – 57 years with a mean age of 22.18 years (SD = 6.87).

Measures and Materials

RNT manipulation (see appendix B). The RNT manipulation was adapted from Roberts and colleagues (2013). Participants were instructed to think about an ongoing and unresolved concern that had been repeatedly coming into their mind over the past week and causing them to feel negative, sad, down, stressed or anxious. They were given examples of appropriate

[1] In addition power was calculated for the moderation hypothesis. Roberts, Watkins & Wills (2013) found that trait rumination was a significant moderator of the effect of goal manipulation on ruminative thoughts, with a moderate effect size of $\Delta r^2 = 0.092$. Using this effect size to detect two-tailed alpha at 0.05, with a power of 0.8, 84 participants would be required (Cohen, 1988).

[2] All participants met these criteria.

[3] Participant's scores on the PHQ9 for item 9 "thoughts that you would be better off dead or of hurting yourself in some way" were checked for suicide risk. Scores >2 would have led to exclusion and risk protocols being followed. All participants scored <1.

topics, and asked to briefly outline the identified concern. Participants were then asked to dwell on this current problem or concern, in the way that they would usually dwell on, ruminate or worry about unresolved concerns. Participants were presented with eight prompts to focus on various aspects of the concern. The prompts included the instructions to "think about what is important about this difficulty in terms of your personal goals". They were then left alone for 10 minutes to work through these prompts. This task has been shown to be effective in inducing RNT (Roberts, et al., 2013). A matched control manipulation asked participants to spend the same period of time thinking about a concern that had previously troubled them and caused them to feel negative, sad, down, stressed or anxious, but was resolved. The seven control prompts included the instructions to "focus on how resolving this problem reflects progress on important personal goals".

Reward sensitivity task (Pizzagalli, Jahn & O'Shea, 2005). The reward sensitivity task is a computerised task that allows for the objective assessment of the participant's propensity to modulate behaviour as a function of prior reinforcements. Participants are asked to select whether stimulus A or stimulus B was presented by pressing a designated key on the keyboard. Performance can be analysed with respect to response bias, which reflects the participant's propensity to select one or the other response irrespective of stimulus presentation. Research has shown that rewarding the correct identification of stimulus A over stimulus B produces a systematic preference for identifying a stimulus as A (Macmillan & Creelman, 1991; McCarthy, 1991). Thus, if the probability of reward is greater for correct identification of stimulus A than for stimulus B, then participants will be more

likely to respond that a given stimulus is A. Accordingly, the degree of response bias toward the more frequently reinforced response can be used to objectively assess reward responsiveness, in that reduced reward responsiveness will lead to a reduced response bias. In accordance with this, previous studies have found that individuals with major depression show reduced response bias on this task (e.g., Pizzagalli et al., 2009).

In the present study (Figure 1) the task was presented on a 20 inch PC monitor using E-Prime software (version 2.0; Psychology Software Tools Inc., Pittsburgh, Pennsylvania). The participants' goal was to determine, via button press, whether a short (11.5 mm) or a long (13 mm) mouth was presented on a previously mouthless cartoon face. The task included 300 trials, divided into three blocks of 100. Each trial started with the presentation of a cross in the middle of the screen for 500msec, which served as a fixation point. After 500msec a mouthless cartoon face was presented, followed by a delay of 500msec, then the short or the long mouth was presented for 100msec. The mouthless face then remained on the screen until a response was recorded. Participants were asked to identify the short or long mouth by pressing the "z" key or the "/" key on the keyboard (counterbalanced across participants). Within each block an equal number of short and long mouths were presented in a pseudo-randomised sequence with no more than three instances of the same stimulus presented consecutively. Stimulus exposure and the difference between mouth sizes was identical to those used in prior studies using this paradigm (Pizzagalli et al., 2005).

To elicit a response bias, an asymmetric reinforcer ratio was utilised (McCarthy & Davison, 1979; Tripp & Alsop, 1999). Specifically, correct

identification of either the short or long mouth is rewarded (‘‘Correct!! You won 5 pence”) three times more often (‘‘rich stimulus”) than correct identification of the other mouth (‘‘lean stimulus”). The reinforcement allocation was counterbalanced across subjects. In each block, only 40 correct trials (30 rich, 10 lean) were rewarded so that each subject was exposed to the same reward ratio. To achieve this goal, a controlled reinforcer procedure was implemented according to prior procedures (Johnstone & Alsop, 2000; McCarthy & Davison, 1979). Accordingly, if participants responded incorrectly on a trial that was scheduled to be rewarded based on a pseudo-randomised reinforcement sequence, the reward feedback was delayed until the next correct identification of the same stimulus type. High response bias scores are produced by high numbers of correct responses to the “rich stimulus” and high numbers of incorrect response to the “lean stimulus”; and are calculated as:

$$\log b = \frac{1}{2}\log\left(\frac{\mathrm{Rich}_{\mathrm{correct}} \times \mathrm{Lean}_{\mathrm{incorrect}}}{\mathrm{Rich}_{\mathrm{incorrect}} \times \mathrm{Lean}_{\mathrm{correct}}}\right)$$

A high response bias emerges when a) there are large numbers of correct responses to the rich stimulus ($\mathrm{Rich}_{\mathrm{correct}}$) and incorrect responses to the lean stimulus ($\mathrm{Lean}_{\mathrm{incorrect}}$), resulting in a large numerator; and b) when there are small numbers of incorrect responses to the rich stimulus ($\mathrm{Rich}_{\mathrm{incorrect}}$) and correct responses for the lean stimulus ($\mathrm{Lean}_{\mathrm{correct}}$), resulting in a smaller denominator (Bogdan & Pizzagalli, 2006).

Discriminability assesses the participants’ ability to perceptually distinguish between the two stimuli, and thus can be used as a proxy of task difficulty. Discriminability in this task was calculated to determine overall task performance and ensure that there were no task-unspecific differences

between the conditions (Pizzagalli et al., 2007). The following formula was used to calculate discriminability:

$$\log d = \frac{1}{2} \log\left(\frac{\text{Rich}_{\text{correct}} \times \text{Lean}_{\text{correct}}}{\text{Rich}_{\text{incorrect}} \times \text{Lean}_{\text{incorrect}}}\right)$$

The formulae for response bias and discriminability were adjusted using the "log-linear rule", which involves adding .5 to every cell of the detection matrix. This allows computation in cases where there is a zero in one cell of the formula (Hautus, 1995 cited in Pizzagalli et al., 2007).

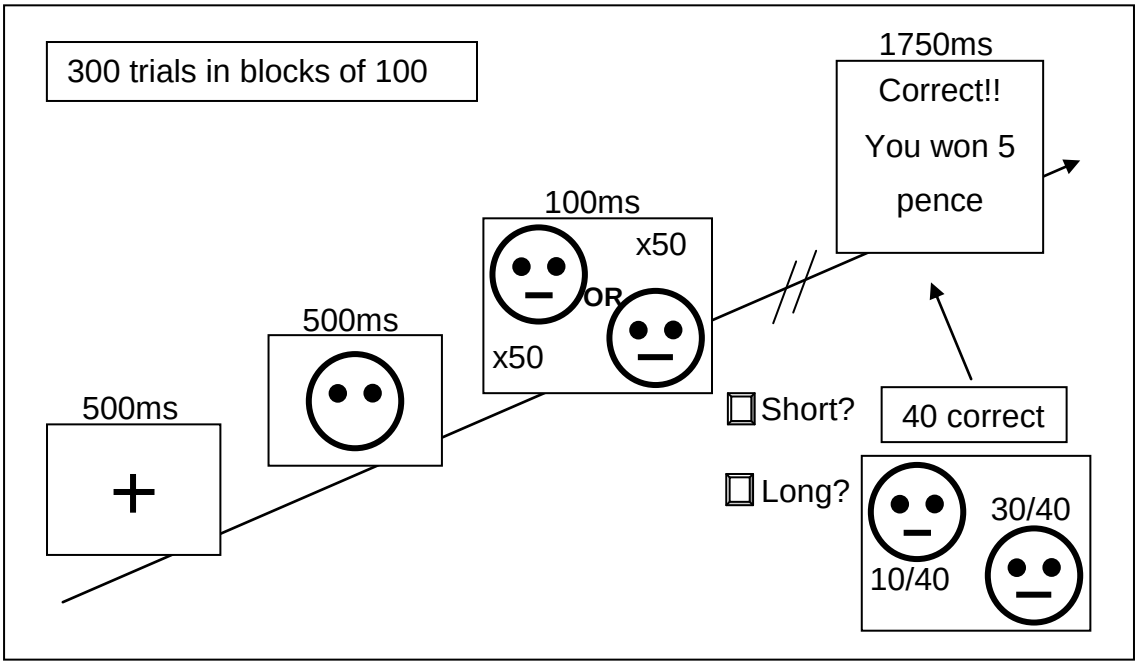

Figure 1. Schematic diagram of the task. Diagram adapted from Pizzagalli and colleagues (2005).

For the task to work as intended (induce response bias), subjects were informed at the beginning of the experiment that the purpose of this task was to win as much money as possible. Moreover, they were instructed that not all correct responses would receive reward feedback but were unaware that

one of the stimuli would be disproportionally rewarded. However, all participants were compensated with course credits for their participation.

The Patient Health Questionnaire (PHQ-9; Kroenke, Spitzer & Williams, 2001; see Appendix C). The PHQ-9 is a nine item self-report measure of depressive symptoms, e.g., "little interest or pleasure in doing things". Responses range from 0 (not at all) to 3 (nearly every day). The PHQ-9 has good test-retest reliability (Kroenke et al., 2001). In this study, internal consistency was good, Cronbach's alpha of 0.76.

Concern rating Likert-type scales (see Appendix D). Concerns were rated using Likert-type scales from 1 – 9, to indicate the following: the importance of the concern (concern importance; 1, not at all important to 9, extremely important); the extent to which it had troubled the participant at its worst (concern worst) and in the past week (concern bothers; 1, not at all troubled by this difficulty to 9, extremely troubled by this difficulty); how frequently the participant had been thinking about the concern (concern frequency; 1, almost never to 9, almost always), how much control the participant had over thinking about the concern (concern control; measured on a scale from 0%, no control to 100%, complete control), and how easy the participant found it to dismiss thinking about the concern (concern dismiss, 1, very easy to 9, very hard) over the past week; how much the concern relates to other concerns (concern relates; 1, not at all related to 9, extremely related); and how many weeks the concern has been a problem for the participant (concern weeks).

Mood, tension and self-focus Likert-type scales (see Appendix E). Current levels of sadness, tension and self-focus were assessed using Likert-

type scales, to identify changes in emotional response (e.g., distress). Participants indicated their current levels of sadness, tension, and self-focus on three bipolar scales ranging from 1 (very sad; very tense; not at all focused on myself) to 9 (very happy; very calm; extremely focused on myself). Likert-type scales have been found to be sensitive and reliable measures of current mood and self-focus (e.g., Watkins & Teasdale, 2001; 2004).

RNT manipulation check Likert-type scales (see Appendix F). A manipulation check for RNT induction during the reward sensitivity task required participants to complete Likert-type scales after each block of the task, with respect to thoughts about the identified concern from the RNT manipulation, during the preceding block. The RNT scales included the following items rated from 1 – 9: frequency of thoughts (1, almost never to 9, almost always), duration of the thoughts (1, only moments to 9, nearly all the time available), how often thoughts returned to the same or similar difficulties (1, almost never to 9, almost always), how hard was it to dismiss thoughts (1, almost never to 9, almost always), and distress level of the thoughts (1, not at all distressing to 9, extremely distressing). To assess state RNT during the reward sensitivity task, a mean RNT score was calculated (sum of scores for frequency, duration, similar thoughts, dismiss and distress, divided by five). Internal consistency of the scale was good: Cronbach's alpha: block 1 = 0.85, block 2 = 0.91, block 3 = 0.88.

The Responses Styles Questionnaire (RSQ; Nolen-Hoeksema, 1991; Treynor, Gonzalez, & Nolen-Hoeksema, 2003; see Appendix G). The RSQ is a 22-item measure of depressive rumination, e.g., "think about how alone you feel". Participants rate what they "generally do" when feeling

sad or depressed on a four-point scale from 1 (almost never) to 4 (almost always). The RSQ has acceptable construct validity, and good test-retest reliability (Nolen-Hoeksema & Morrow, 1993; Treynor et al., 2003). In this study, internal consistency was good, Cronbach's alpha of 0.93.

The Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990; see Appendix H). The PSWQ is a 16-item self-report measure of worry phenomena, e.g., "I am always worrying about something". Participants rate how typical each item is of them from 1 (not at all typical of me) to 5 (very typical of me). The PSWQ has good construct validity (Brown, Antony, & Barlow, 1992). In this study, internal consistency was good, Cronbach's alpha of 0.94.

The Autobiographical Memory Questionnaire (AMQ; Rubin, Schrauf, & Greenberg, 2003; see Appendix I). The AMQ is a self-report questionnaire of autobiographical memory characteristics. Participants were asked to retrieve the most positive event from their past and rate it on selected questions from the AMQ. This task was implemented as a successful means to improve the mood of participants at the end of the experiment – i.e., as a simple positive mood induction.

Procedure

Participants attended one session; they were given the information sheet (see Appendix J) and consent form (see Appendix K) at the beginning of the session. They then completed the PHQ-9 and a demographics questionnaire (see Appendix L). Participants were given verbal and written instructions (presented through E-Prime) on how to complete the reward sensitivity task and were allowed to practice as many times as they required

to feel confident with the task. They then completed computerised versions of the mood, tension and self-focus scales. Participants were given verbal instructions to identify a concern and asked to complete the concern ratings scale to assess whether it was appropriate; they then completed the RNT induction (randomised to resolved versus unresolved conditions). Following the RNT induction, participants repeated the computerised versions of the mood, tension and self-focus scales, and began the experimental task. After each block of the reward sensitivity task, participants completed the mood, tension, self-focus and RNT scales. On completion of the task they were given the RSQ, PSWQ and finally the AMQ. Participants were thanked for their participation awarded course credits and offered a verbal debrief of the study. Participants who scored >15 on the PHQ-9 (N=1) were offered information on services available to provide support with depression and low mood (see Appendix M).

Data Analysis

Following the standard procedure used for the reward sensitivity task (Pizzagalli et al., 2005), for all analyses, trials with reaction times (RT) shorter than 150 msec or longer than 2500 msec were excluded (overall, 2.21% of the trials). Furthermore, for each participant, trials with RT (after natural log transformation) falling outside the range of mean ±3 standard deviation (SD) were considered outliers. Overall, an additional 0.74% of trials were excluded for all analyses. Cases were excluded when RT on the reward sensitivity task were shorter than 150msec or longer than 2500msec for more than 20% of trials in at least one block, resulting in three cases being excluded. A further three cases were excluded as accuracy rates were less than 55% in at least

one block, indicating poor task performance and limited attention to task instructions.

In addition, all variables were checked for univariate outliers by calculating standardised scores (z-scores), where outliers were taken to be z-scores ±3.29 SD. This identified four outliers in total, with these scores excluded due to their extreme nature[4]. One case was excluded due to being a significant outlier with regards to their age (>3 SD above the mean). After cases were excluded, results from a total of 84 participants were analysed (resolved goal, n=41, unresolved goal, n=43).

All variables were checked to determine whether they met parametric assumptions of normality and homogeneity of variance by examining histograms and Kolmogorov-Smirnov and Levene's tests. The majority of tests and inspection of histograms were consistent with an assumption of normality, and given the large sample size, assumptions of normality were considered robust enough for parametric testing[5].

Unpaired *t*-tests and Pearson's chi square tests were used to examine differences between the conditions on demographic variables, baseline measures, trait measures, and concern ratings. To check whether the RNT manipulation worked, a mixed 2 (Condition: resolved versus unresolved) by 3 (Time: block 1, block 2, block 3) Analysis of Variance (ANOVA) was carried out with mean RNT, mood and self-focus as the dependent variables. As a further manipulation check, separate 2 (Condition: resolved versus

[4] Some participants chose a concern that had been a problem for them for a long period of time or from many years ago, therefore the SDs were large and using other methods, such as limiting the scores to 3.29 SD, did not reduce the impact of the outliers.

[5] Both the raw data and transformed data, using a natural log transform, to reduce positive (i.e., state RNT variables) or negative skew (i.e., response bias variables) and improve consistency with assumptions of normality, produced equivalent patterns of results, and therefore the uncorrected data is reported

unresolved) by 2 (Time: pre-manipulation, post-manipulation) mixed ANOVAs were carried out with mood, self-focus, and tension scores as the dependent variables. To test for possible differences between the conditions on the reward sensitivity task, separate mixed 2 (Condition: resolved versus unresolved) by 3 (Time: block 1, block 2, block 3) ANOVAs were carried out with response bias and discriminability scores as the dependent variables. In addition, a mixed 2 (Condition: resolved versus unresolved) by 2 (Stimulus type: rich, lean) by 3 (Time: block 1, block 2, block 3) ANOVA was carried out with accuracy scores as the dependent variable. Where appropriate, the Greenhouse-Geisser correction was applied. Throughout, partial eta squared (η^2_p) effect sizes are reported.

Results

Participant Characteristics

There were no significant differences between the experimental conditions on demographic variables: age, $t(82) = 0.58$, $p = .56$, gender, $\chi^2(1, n=84) = 0.46$, $p = .42$, ethnicity, $\chi^2(5, n=84) = 3.65$, $p = .60$, education level, $\chi^2(1, n=84) = 0.01$, $p = .92$ and handedness, $\chi^2(1, n=84) = 0.82$, $p = .36$. There were no significant differences between the experimental conditions on trait measures of depression (PHQ-9), $t(69.47) = 1.31$, $p = .19$ (equal variances not assumed), rumination (RSQ), $t(82) = 1.74$, $p = .08$, and worry (PSWQ), $t(77.26) = 0.10$, $p = .92$ (equal variances not assumed), or baseline levels of sadness, $t(82) = -1.64$, $p = .11$, tension, $t(82) = 0.25$, $p = .80$ and self-focus $t(82) = -0.64$, $p = .52$ (see Table 1 for frequencies, means and SD).

Table 1

Means, Standard Deviations (SD), and Frequencies for Demographic, Trait Measures, and Baseline Variables for Unresolved Goal and Resolved Goal Conditions.

Variable	Resolved (n=42) Means (SD)	Unresolved (n=43) Means (SD)
Age	22.20 (6.67)	21.44 (5.16)
Gender	Female = 36	Female = 35
	Male = 5	Male = 8
Ethnicity	White British = 32	White British = 32
	White Other = 5	White Other = 8
	Chinese = 1	Chinese = 0
	Latin American = 1	Latin American = 0
	Black African = 0	Black African = 1
	Mixed = 2	Mixed = 2
Education	Undergraduate = 33	Undergraduate = 35
	Postgraduate = 8	Postgraduate = 8
Handedness	Left = 4	Left = 2
	Right = 37	Right = 41
PHQ-9	5.98 (1.17)	6.40 (1.18)
RSQ	49.12 (13.98)	45.11 (12.51)
PSWQ	52.05 (16.99)	52.98 (13.86)
Baseline Mood	6.00 (1.17)	6.39 (1.17)
Baseline Self-focus	5.49 (1.57)	5.70 (1.44)
Baseline Tension	5.98 (1.68)	5.88 (1.65)
Concern Importance	7.17 (1.45)	7.65 (0.87)
Concern Worst	7.88 (1.12)	7.95 (1.00)
Concern Bothers	1.68 (0.76)	6.63 (1.02)
Concern Frequency last week	1.73 (0.81)	6.98 (1.30)
Concern Control	87.80 (19.06)	43.49 (19.23)
Concern Dismiss	2.02 (1.63)	5.98 (1.61)
Concern Duration[6]	20.31 (22.78)	8.15 (12.68)
Concern Relates to other goals	3.83 (2.42)	5.12 (2.32)

Note: PHQ-9 = Patient Health Questionnaire; RSQ = Response Styles Questionnaire; PSWQ = Penn State Worry questionnaire

[6] Concern duration values exclude extreme outliers. The values for concern duration including the extreme outliers for the resolved condition are, M = 48.49, SD = 128.06, and for the unresolved condition are, M = 13.21, SD = 26.44.

Characteristics of the Identified Concern between Conditions

As expected, participants in the unresolved goal condition reported having significantly more thoughts of the goal cued in the last week, $t(82) = -22.09$, $p < .001$, being significantly more bothered by the goal, $t(82) = -25.08$, $p < .001$, having significantly less control over thinking about the goal, $t(82) = 10.60$, $p < .001$, having significantly more difficulty dismissing thoughts about the goal, $t(82) = -11.16$, $p < .001$, and that the goal significantly related to other concerns, $t(82) = -2.49$, $p = .01$ more than the participants in the resolved goal condition (see Table 1 for means and SD). Participants in the resolved goal condition rated the goal as having been a concern for significantly longer than participants in the unresolved goal condition, $t(58.86) = 2.97$, $p = .005$ (equal variances not assumed; which reflected that it may have been a resolved goal from their past). There was no significant effect of condition on participants' evaluation of how much the goal had bothered them at its worst, $t(82) = -0.33$, $p = .74$, or the importance of the goal, $t(64.95) = -1.83$, $p = .07$ (equal variances not assumed). Thus, the goals identified in the two conditions did not differ on participants' evaluations of severity or importance, but participants in the unresolved goal condition reported that the goal was more of a problem for them currently than participants in the resolved goal condition.

Initial and Maintained Effects of the RNT Manipulation on Mood, Tension, Self-Focus, and State RNT

Separate 2 (condition: unresolved goal, resolved goal) x 2 (time: pre-RNT manipulation, post-RNT manipulation) mixed ANOVAs examined the impact of the RNT manipulation on participants' mood, tension, and self-

focus. There was a significant main effect of time on sadness, $F(1, 82) = 88.45$, $p < .001$, $\eta^2_p = .52$ reflecting sadder mood following the manipulation. There was no significant main effect of condition, $F(1, 82) = 0.01$, $p = .91$, $\eta^2_p < .001$. There was a significant interaction of condition by time, $F(1, 82) = 10.39$, $p = .002$, $\eta^2_p = .11$, reflecting a greater increase in sadness in the unresolved condition versus the resolved condition, as expected (Table 2).

There was a significant main effect of time on tension, $F(1, 82) = 24.06$, $p < .001$, $\eta^2_p = .23$, reflecting an increase in tension after the manipulation. There was no significant main effect of condition, $F(1, 82) = 1.62$, $p = .21$, $\eta^2_p = .02$ and no significant interaction of condition by time, $F(1, 82) = 1.59$, $p = .21$, $\eta^2_p = .02$. Thus the conditions did not differ in their level of tension following the manipulation.

Table 2

Means and Standard Deviations (SD) for Sadness-to-Happiness, Tension-to-Calmness, and Self-Focus Across all Time Points.

	Sadness-to-Happiness		Tension-to-Calmness		Self-focus	
Time	Resolved	Unresolved	Resolved	Unresolved	Resolved	Unresolved
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Pre-manipulation	5.98 (1.17)	6.40 (1.79)	5.98 (1.68)	5.88 (1.65)	5.49 (1.57)	5.70 (1.44)
Post-manipulation	5.12 (1.12)	4.65 (1.34)	5.22 (1.37)	4.60 (1.62)	5.63 (1.59)	6.23 (1.56)
Block 1	5.17 (1.38)	5.07 (1.08)	5.29 (1.35)	4.93 (1.47)	5.00 (1.76)	5.44 (1.58)
Block 2	5.39 (1.20)	5.09 (1.06)	5.32 (1.68)	5.21 (1.42)	4.63 (1.83)	5.26 (1.68)
Block 3	5.29 (1.12)	5.14 (1.12)	5.66 (1.64)	5.47 (1.59)	4.85 (1.92)	5.40 (1.59)

Note. Sadness-to-Happiness scores on a scale from 1 (very sad) – 9 (very happy), lower scores = sadder mood; Tension-to-Calmness scores on a scale from 1 (very tense) – 9 (very calm), lower scores = increased tension; Self-focus scores on a scale from 1 (not at all focussed on myself) to 9 (extremely focussed on myself), higher scores = increased self-focus.

For self-focus, there was a trend towards a significant main effect of condition, $F(1, 82) = 2.77$, $p = .1$, $\eta^2_p = .03$, reflecting that participants in the unresolved goal condition reported higher levels of self-focus before the RNT manipulation than participants in the resolved goal condition, and this remained constant after the manipulation. There was no significant main effect of time on self-focus, $F(1, 82) = 2.15$, $p = .15$, $\eta^2_p = .03$ and no significant interaction of condition by time, $F(1, 82) = 0.69$, $p = .41$, $\eta^2_p = .01$. Thus self-focus remained constant throughout the RNT manipulation for both conditions.

Separate 2 (condition: unresolved goal, resolved goal) x 3 (time: block 1, block 2, block 3) mixed ANOVAs examined whether the effects of sadness and self-focus are maintained during the reward sensitivity task. There were no significant main effects of condition, $F(1, 82) = 0.72$, $p = .40$, $\eta^2_p = .01$, or time, $F(1.78, 146.30) = 0.62$, $p = .54$, $\eta^2_p = .01$ (Greenhouse-Geisser correction applied) on sadness. There was no significant interaction of condition by time, $F(1.78, 146.30) = 0.39$, $p = .65$, $\eta^2_p = .005$ (Greenhouse-Geisser correction applied). Mood remained relatively stable over time for both the unresolved goal and resolved goal conditions.

There was no significant main effect of condition, $F(1, 82) = 0.72$, $p = .40$, $\eta^2_p = .01$, or time on self-focus, $F(1.78, 146.19) = 1.38$, $p = .25$, $\eta^2_p = .02$ (Greenhouse-Geisser correction applied). There was no significant interaction of condition by time, $F(1.78, 146.19) = 0.14$, $p = .84$, $\eta^2_p = .002$ (Greenhouse-Geisser correction applied). Self-focus remained relatively stable over time for both the unresolved goal and resolved goal conditions.

A 2 (condition: unresolved goal, resolved goal) x 3 (time: block 1, block 2, block 3) mixed ANOVA examined whether RNT about the identified concern was elevated and more persistent when the concern was unresolved than when it was resolved (this was the critical manipulation check for the RNT inductions). As intended, there was a significant main effect of condition, $F(1, 82) = 11.68$, $p = .001$, $\eta^2_p = .12$, reflecting higher levels of RNT in the unresolved condition ($M = 2.72$, $SD = .23$) than in the resolved condition ($M = 1.79$, $SD = .14$). There was also a significant main effect of time, $F(1.69, 138.73) = 3.17$, $p = .05$, $\eta^2_p = .04$ (Greenhouse-Geisser correction applied), reflecting that levels of RNT reduced over time for both conditions. There was no significant interaction of condition by time, $F(1.69, 138.73) = 0.12$, $p = .85$, $\eta^2_p = .002$ (Greenhouse-Geisser correction applied). To further examine the main effect of time, this was examined separately from block 1 to block 2 and from block 2 to block 3. This showed no significant change in RNT from block 1 ($M = 2.38$, $SD = 1.45$) to block 2 ($M = 2.35$, $SD = 1.55$), $F(1, 82) = 0.03$, $p = 0.87$, $\eta^2_p < .001$, and a significant reduction in RNT from block 2 to block 3 ($M = 2.09$, $SD = 1.48$), $F(1, 82) = 7.59$, $p = .01$, $\eta^2_p = .08$. Thus participants with an unresolved concern had greater levels of RNT than participants with a resolved concern throughout the task, and levels of RNT reduced over time in both conditions (Figure 2)[7]. These results confirm that the RNT manipulation

[7] In addition 2 (condition: unresolved goal, resolved goal) x 3 (time: block 1, block 2, block 3) mixed ANOVAs were used to examine the individual components of the RNT scale, frequency, duration, similar ideas, ease of dismissal and distress. There were significant main effects of time, $F(1.69, 138.6) = 6.855$, $p = .003$, $\eta^2_p = .08$, and condition, $F(1, 82) = 7.31$, $p = .01$, $\eta^2_p = .08$ for frequency, reflecting that the frequency of thoughts reduced from block 1 ($M = 2.43$, $SD = 1.72$) to block 3 ($M = 1.89$, $SD = 1.48$) for both conditions and that the frequency of thoughts for participants in the unresolved condition was greater ($M = 2.67$, $SD = 1.87$) than for those in the resolved condition ($M = 1.89$, $SD = 0.1.39$). There were significant main effects of time, $F(2, 164) = 3.63$, $p = .03$, $\eta^2_p = .04$, and condition, $F(1, 82) = 11.39$, $p = .001$, $\eta^2_p = .12$ for duration, reflecting that the duration of thoughts reduced from block 1 ($M = 1.63$, $SD = 1.24$) to block 3 ($M = 1.56$, $SD = 1.18$) for both conditions and that

was successful and that the effects on RNT were maintained through the reward sensitivity task.

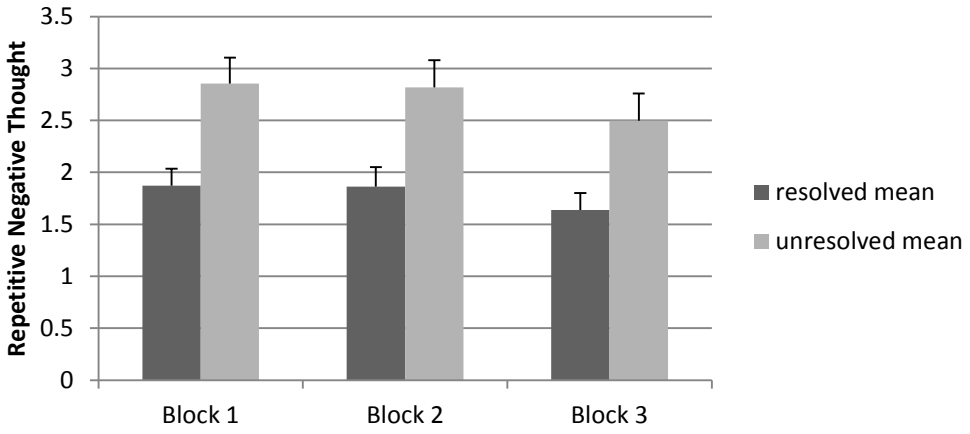

Figure 2. Mean state RNT during the reward sensitivity task. Error bars denote SE.

The Effects of RNT Manipulations During the Reward Sensitivity Task

Response bias. A 2 (condition: unresolved goal, resolved goal) x 3 (time: block 1, block 2, block 3) repeated measures ANOVA examined whether the RNT manipulation had an effect on response bias. There was a significant main effect of time, $F(2, 164) = 4.59$, $p = .01$, $\eta^2_p = .05$. There was no significant main effect of condition, $F(1, 82) = 2.35$, $p = .13$, $\eta^2_p = .03$, or significant interaction of condition by time, $F(2, 164) = 0.99$, $p = .37$, $\eta^2_p = .01$ (see Table 3). To further examine the main effect of time, the effect of time

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participants' thoughts in the unresolved condition lasted longer ($M = 2.08$, $SD = 1.65$) than for those in the resolved condition ($M = 1.27$, $SD = 0.57$). There was a significant main effect of condition, $F(1, 82) = 8.31$, $p = .005$, $\eta^2_p = .09$, for similar ideas, reflecting that thoughts returned to similar ideas more frequently for participants in the unresolved condition ($M = 3.37$, $SD = 2.5$) than for those in the resolved condition ($M = 2.15$, $SD = 1.97$). There was no significant main effect of condition for ease of dismissal, $F(1, 82) = 3.3$, $p = .07$, $\eta^2_p = .04$. There were significant main effects of time, $F(1.61, 131.91) = 5.66$, $p = .01$, $\eta^2_p = .06$, and condition, $F(1, 82) = 15.64$, $p < .001$, $\eta^2_p = .16$, for distress, reflecting that the level of distress reduced from block 1 ($M = 2.61$, $SD = 1.77$) to block 3 ($M = 2.14$, $SD = 1.61$) for both conditions and that participants in the unresolved condition showed higher levels of distress ($M = 2.97$, $SD = 1.83$) than those in the resolved condition ($M = 1.77$, $SD = 1.22$).

was examined separately from block 1 to block 2 and from block 2 to block 3. This showed a significant increase in response bias from block 1 (M = .06, SD = .22) to block 2 (M = .14, SD = .27), $F(1, 82) = 7.71$, $p = .01$, $\eta^2_p = .09$, and no significant change in response bias from block 2 to block 3 (M = .13, SD = .31), $F(1, 82) = 0.08$, $p = .78$, $\eta^2_p = .001$ (Figure 3A).

Table 3.

Means and SD for Response Bias in Blocks 1 – 3.

	Resolved (n=42) Means (SD)	Unresolved (n=43) Means (SD)
Block 1	.07 (.19)	.04 (.25)
Block 2	.17 (.25)	.11 (.28)
Block 3	.19 (.25)	.07 (.35)

Previous studies have found that response bias tends to increase over blocks as there are more trials to learn the differential reward contingency, and that this effect was reduced in those with elevated depression or stress (e.g., Pizzagalli et al., 2007). We therefore examined the effect of condition on block 3 alone, using a one-way ANOVA, as this may provide the most sensitive index of experimental effects on response bias. We expect the extent of response bias to increase with subsequent blocks (and to be low in block 1 in particular) and thus the differential sensitivity to detect any effect of an experimental manipulation to increase in later blocks. There was a trend towards a significant difference between the unresolved and resolved conditions, $F(1, 83) = 3.14$, $p = .08$, $\eta^2_p = .04$, reflecting lower response bias in

the unresolved condition in comparison to the resolved condition (see Table 3).

Accuracy. To examine the contribution of each stimulus type on accuracy, a 2 (condition: unresolved goal, resolved goal) x 2 (stimulus type: rich, lean) x 3 (time: block 1, block 2, block 3) mixed ANOVA was conducted on accuracy scores. There was a significant main effect of stimulus type, $F(1, 82) = 34.51$, $p = .001$, $\eta^2_p = .30$, due to greater accuracy for the rich ($M = .86$, $SD = .07$) compared to the lean ($M = .79$, $SD = .10$) stimulus (Figure 3B), replicating previous studies. There was a significant interaction of time by stimulus type, $F(1.80, 147.95) = 7.79$, $p < .001$, $\eta^2_p = .09$ (Greenhouse-Geisser correction applied). There were no significant main effects of condition, $F(1, 82) = 0.43$, $p = .51$, $\eta^2_p = .005$, or time, $F(1.65, 134.99) = 1.98$, $p = .15$, $\eta^2_p = .02$ (Greenhouse-Geisser correction applied). There were no significant interactions of time by condition, $F(1.65, 134.99) = 2.14$, $p = .13$, $\eta^2_p = .02$ (Greenhouse-Geisser correction applied), stimulus type by condition, $F(1, 82) = 1.82$, $p = .18$, $\eta^2_p = .02$, or time by stimulus type by condition, $F(1.80, 147.95) = 0.46$, $p = .61$, $\eta^2_p = .01$ (Greenhouse-Geisser correction applied). The significant interaction of time by stimulus type was due to a significant difference between the change in accuracy rates for the rich and lean stimulus from block 1 (rich: $M = .84$, $SD = .09$; lean: $M = .80$, $SD = .10$) to block 2 (rich: $M = .88$, $SD = .08$; lean: $M = .79$, $SD = .12$), $F(1, 82) = 11.09$, $p = .001$, $\eta^2_p = .12$ and no significant difference between the change in accuracy rates from block 2 to block 3 (rich: $M = .87$, $SD = .08$; lean: $M = .77$, $SD = .14$), $F(1, 82) = 0.48$, $p = .49$, $\eta^2_p = .01$. Therefore, consistent with prior studies, accuracy for the rich stimulus was greater than for the lean stimulus overall,

but, inconsistent with prior studies; there were no effects of condition on accuracy.

Discriminability. A 2 (condition: unresolved goal, resolved goal) x 3 (time: block 1, block 2, block 3) ANOVA examined whether the RNT manipulation had an effect on discriminability. There was a significant main effect of time, $F(2, 164) = 3.43$, $p = .03$, $\eta^2_p = .04$. There was no significant main effect of condition, $F(1, 82) = 0.36$, $p = .55$, $\eta^2_p = .004$ and no significant interaction of condition by time, $F(2, 164) = 1.44$, $p = .24$, $\eta^2_p = .02$ (Figure 3C). Therefore, consistent with prior studies, there were no significant differences between the conditions on their ability to discriminate between the stimuli in the task. To further examine the main effect of time, the effect of time was examined separately from block 1 to block 2 and block 2 to block 3. This showed a significant increase in discriminability from block 1 ($M = .72$, $SD = .24$) to block 2 ($M = .78$, $SD = .25$), $F(1, 82) = 6.10$, $p = .02$, $\eta^2_p = .07$, and no significant difference from block 2 to block 3 ($M = .76$, $SD = .28$), $F(1, 82) = 0.74$, $p = .39$, $\eta^2_p = .01$ (Figure 3C).

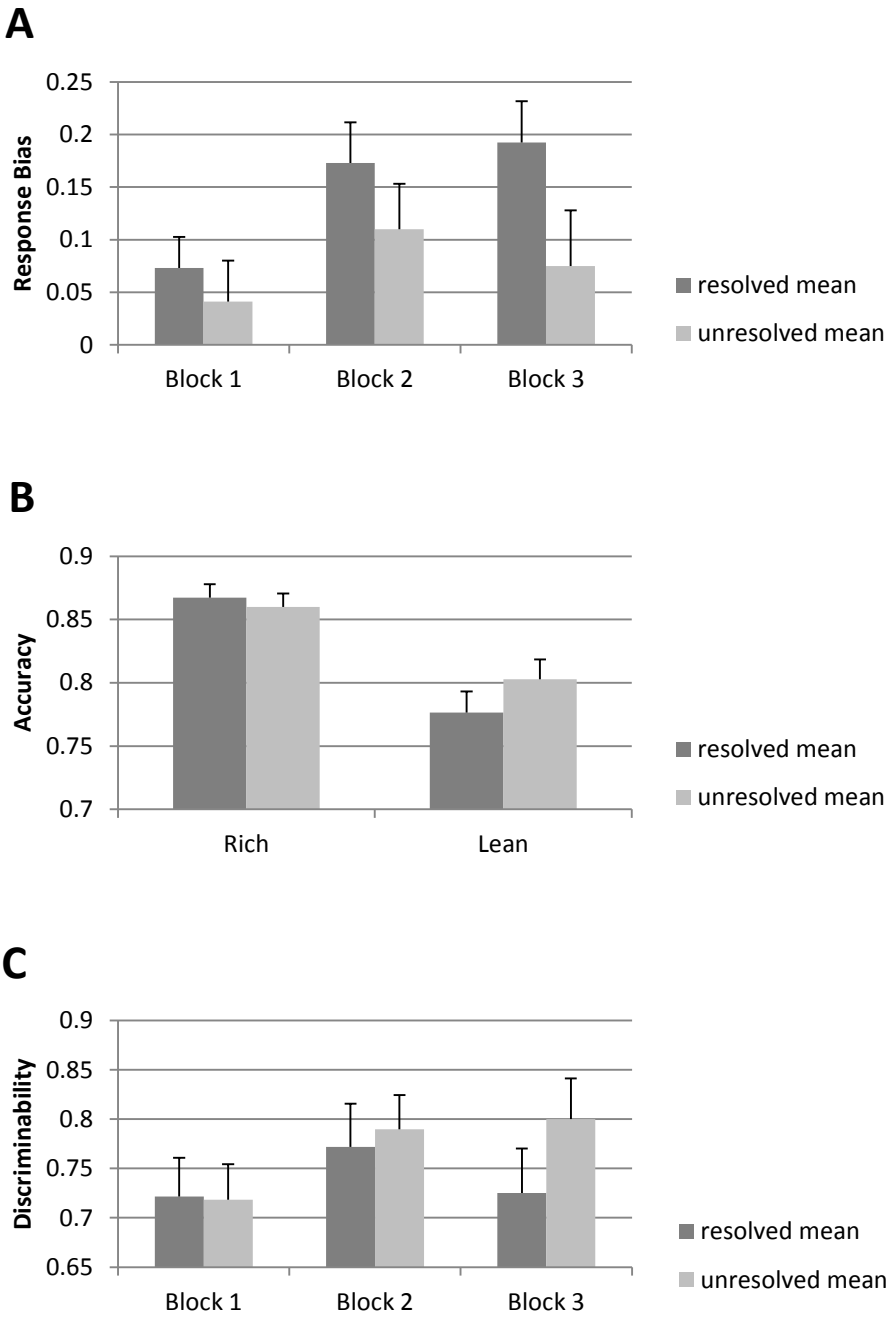

Figure 3. Overall effect of RNT manipulation on behavioural measures. (A) Response bias, (B) Mean accuracy (averaged across the three blocks) for the more frequently rewarded (rich) stimulus and the lean stimulus, and (C) Discriminability. Error bars represent standard errors.

Correlation Matrix for Trait RNT, State RNT, Overall Accuracy, Overall Response Bias and Overall Discriminability

The relationship between the key independent and dependent variables was examined; see Table 4 for the correlation matrix.

Table 4

Correlation Matrix for Trait RNT, State RNT, Overall Accuracy, Overall Response Bias and Overall Discriminability (Pearson's Correlation Coefficient).

	1		2		3		4		5	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
1. Trait RNT	–									
2. State RNT	.24*	.03	–							
3. Overall Accuracy	-.23*	.03	-.2	.06	–					
4. Overall Response Bias	.05	.68	.02	.83	-.18	.11	–			
5. Overall Discriminability	-.21	.06	-.25*	.02	.96**	.000	-.1	.38	–	

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Trait RNT and Reward Sensitivity

Rumination and worry scores were significantly correlated, $r = .42$, $p < .001$, therefore these scores were amalgamated (PSWQ score multiplied by 1.1 so that total score equivalent to RSQ max score [88]; [PSWQ + RSQ]/2) to create a mean trait RNT score. Hierarchical regression was used to examine whether trait RNT moderated the effect of condition on overall reward sensitivity during the reward sensitivity task. Condition (0: resolved, 1: unresolved) was entered in step 1 of the regression, centred trait RNT scores

(RNTc) were entered in step 2, and the interaction term (condition x RNTc) was entered in step 3 (Table 5).

Table 5.

Hierarchical Multiple Regression Analyses Predicting Response Bias From Condition (Unresolved, Resolved) and Trait RNT.

	ΔR^2	B	S.E.	β
Step 1				
Condition	.01	-.065	.044	.163
Step 2				
Condition		-.064	.044	.16
Trait RNT	.003	.000	.002	-.029
Step 3				
Condition		-.063	.044	-.157
Trait RNT		.002	.002	.145
Condition x Trait RNT	.03	-.006	.004	-.263†

†p < .1

There were no significant main effects of condition, ΔR^2 = .01, $F(1, 82) = 2.23$, p = .14, or trait RNT, ΔR^2 = .003, $F(1, 81) = 0.07$, p = .79. There was a trend towards significance of the interaction term explaining an increase in variance of reward sensitivity, ΔR^2 = .03, $F(1, 80) = 3.35$, p = .07 (see Figure 4). Thus, trait RNT was trending towards being a moderator of the RNT manipulation on response bias during the reward sensitivity task. This suggests that the effect of the RNT manipulation on subsequent response bias was greater for participants reporting high levels of trait RNT in the unresolved condition.

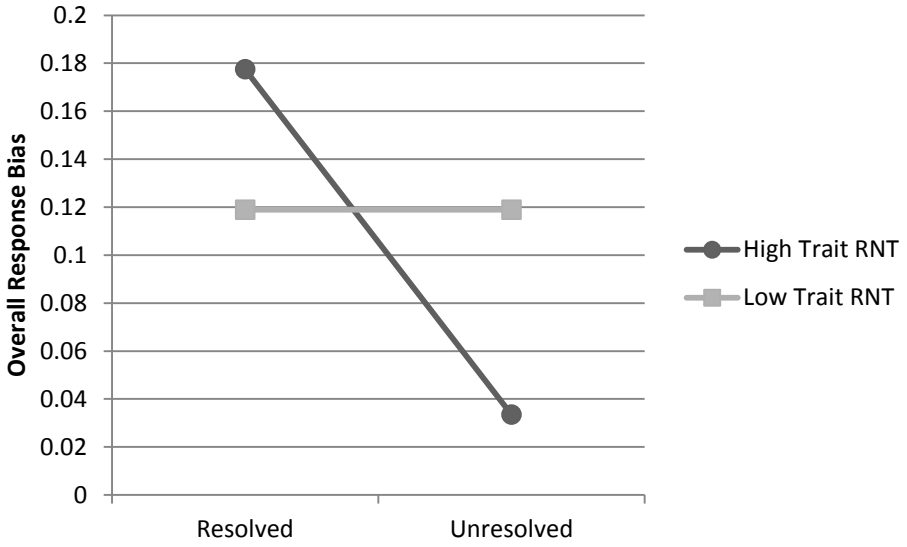

Figure 4. Simple slopes for overall response bias ±1SD of the mean trait RNT score.

Discussion

The main aim of the current study was to examine the hypothesis that RNT causally contributes to anhedonia by experimentally manipulating levels of RNT prior to a reward sensitivity task as a behavioural measure of anhedonia. The hypothesis that the unresolved goal condition would demonstrate less reward sensitivity relative to the resolved goal condition was not supported. There were no significant differences between the unresolved and resolved goal conditions across blocks 1 to 3 in total on reward sensitivity. The simplest conclusion is therefore that RNT does not causally influence anhedonia, as operationalised in terms of reward sensitivity.

Response bias is expected to increase across the blocks due to repeated trials improving learning of differential reinforcement towards rewarded stimuli. Consistent with this, there was a significant main effect of time indicating that there was an increase in response bias from block 1 to

block 2, with this levelling off in block 3, replicating prior studies (e.g., Bogdan & Pizzagalli, 2006). When block 3 was examined alone, there was a trend towards a significant difference between the conditions with the unresolved goal condition producing lower levels of response bias relative to the resolved goal condition. Thus, a tentative conclusion is that it is possible that RNT can cause anhedonia when tested when the index is known to be most sensitive, but this is only a trend finding and needs to be treated with caution.

It was also predicted, in line with the findings of Roberts and colleagues (2013), that there would be a main effect of condition on state RNT. This hypothesis was supported; the levels of state RNT during the reward sensitivity task were greater for participants in the unresolved goal condition relative to the resolved goal condition, confirming that the RNT manipulation was successful. There was no significant difference in the reduction of RNT over time across conditions. This is consistent with previous findings (Roberts et al., 2013). These findings indicate that the manipulation of RNT was effective in producing and maintaining higher levels of RNT in the unresolved goal condition. Analysis of the individual components of the RNT scale indicated that participants in the unresolved goal condition were significantly more distressed by their thoughts than those in the resolved goal condition, thus indicating that the manipulation was effective in producing negatively valenced repetitive thought in the unresolved goal condition, relative to the resolved goal condition. In addition, participants in the unresolved goal condition displayed a greater increase in sadness post-manipulation than those in the resolved condition, as expected. Contrary to prediction, participants did not display any differences in self-focus, which

remained constant after the manipulation. Throughout the reward sensitivity task, levels of sadness and self-focus remained constant for both conditions equally.

The final hypothesis was that trait RNT would moderate the effects of manipulating RNT, specifically that those with elevated trait RNT would be more likely to have reduced reward sensitivity post manipulation in the unresolved goal condition than those with low trait RNT. There was a trend towards a significant interaction of condition by trait RNT. It is possible that there was a greater effect of the RNT manipulation for participants displaying high trait RNT in terms of more frequent or more impactful RNT, but as this was not significant, this result should be interpreted with caution.

To the author's knowledge, this is the first study to directly examine the effects of RNT using a behavioural measure of anhedonia. Cross-sectional (e.g., Nelson & Mazure, 1985) and longitudinal studies (e.g., Killingsworth & Gilbert, 2010) have identified a relationship between RNT and anhedonia, with preliminary evidence that RNT influences positive affect (e.g., Huffziger et al., 2012), but anhedonia has not previously been investigated directly. The measure of anhedonia in this study specifically measures participants' reward sensitivity and their ability to develop a response bias, which is a measure of reward learning (Pizzagalli et al., 2009). It does not measure consummatory or anticipatory anhedonia, and, therefore a different pattern of results may be found when measuring these aspects. Thus the current findings suggest that RNT does not causally affect participants' ability to learn reward relationships.

In the current study, the null hypothesis was not disconfirmed, i.e., RNT does not causally contribute to anhedonia, more specifically it does not have a negative impact on reward learning. Although the current findings did not support the hypothesis that RNT causally contributes to anhedonia, there were trend findings, which tentatively suggest that RNT may influence anhedonia (specifically reward learning), either in more vulnerable high trait RNT individuals or when there has been more learning to influence response bias (block 3). These findings could be false positives or could reflect the fact that an effect of RNT on anhedonia could be found in circumstances where either the effect of the manipulation is enhanced or the sensitivity of the response bias index is improved. To be confident about these findings, replication is required in larger samples. In addition, it is hypothesised that the mechanism by which RNT causally contributes to anhedonia is the focus of attention, i.e., that individuals are focused on the RNT at the expense of the environment (Lehtonen et al., 2009). Therefore, it could be that the lack of significant findings relating to self-focus in the current study was responsible for the findings.

One explanation for the lack of significant findings is the low level of depressive symptoms in the current sample. Previous studies using the reward sensitivity task have found a main effect of depression on reward sensitivity in clinical (Pizzagalli et al., 2009) and non-clinical samples (Pizzagalli et al., 2005). In the current study, the mean PHQ-9 score was at the low end of the mild depression category for both conditions; thus the sample were not displaying many depressive symptoms. Although participants were asked to focus on an unresolved goal, if they were not

depressed and or worried, the effect of focussing on an unresolved goal may not have had as great an impact on state RNT as it would in someone who was either currently depressed or worried. It may be that the reward sensitivity task is only sensitive when used to compare groups displaying high and low levels of depression.

In addition, although the RNT manipulation was effective, this may not have had enough impact to reduce reward sensitivity in this task. The mean RNT score for the unresolved condition was only 3 with a maximum score of 9. Bogdan and Pizzagalli (2006) found decreased reward sensitivity following a stress manipulation relative to a no-stress condition prior to the reward sensitivity task. The first stress manipulation was the threat of shock; participants were instructed that they were more likely to receive a shock if their performance was worse than past participants. The second was performance feedback in comparison to past participants. These manipulations were powerful – it may be that in order for the RNT manipulation to produce an effect it would need to be more powerful. Contrary to this explanation, Roberts and colleagues (2013) did find an effect of the unresolved goal condition versus the resolved goal condition on performance on a cognitive task even in participants with a low level of depression. However, this study used a cognitive task (sustained attention response task), which is less effortful and engaging than the current reward sensitivity task.

Furthermore, although power for the current study was estimated based on prior studies (Pizzagalli et al., 2009; Roberts et al., 2013) it may be that the effect size for the manipulation in the current study is smaller than

that found in these studies. If this were the case then the current study may have been underpowered to detect any effect.

There were a number of strengths to this study. Firstly, the experimental design allowed a stronger inference to be made about causality, while controlling for extraneous variables. Secondly, the manipulation of RNT using the unresolved versus resolved goal induction, with a manipulation check to ensure this had worked, allowed the study to be carried out on non-depressed participants. This manipulation also engages more naturalistic RNT that is involuntarily rather than voluntarily induced. Previous RNT manipulations (Nolen-Hoeksema & Morrow, 1993) have depended on participants' displaying depressive symptoms and having to voluntarily engage in RNT. Thirdly, we used the reward sensitivity task, which is a proven behavioural measure of anhedonia, specifically measuring reward learning (and not anticipatory or consummatory anhedonia), for the first time in this context.

There were also a number of limitations in the current study. Firstly, the sample consisted of primarily female students, so it is unclear to what extent the findings can be generalised to a broader population. Secondly, in addition to this, the sample was non-clinical and participants were not actively selected to have high depressive or worry symptoms. Therefore it is possible that the lack of significant findings was due to the nature of the sample, and different effects may be found in a clinical sample or those with high depressive or worry symptoms. Thirdly, there was no manipulation check for the level of RNT, directly after the RNT manipulation, prior to the reward sensitivity task. Therefore, although the manipulation was shown to be

effective throughout the task, it is not possible to determine the levels of RNT that were present prior to starting the reward sensitivity task. It is possible that the task acted as a distraction to the induced RNT, which could explain the variation in results and would indicate that a more powerful manipulation would be more effective.

Due to the lack of significant findings, few clinical implications can be drawn from the current study. If the null hypothesis is true, as suggested by these findings, then RNT does not cause anhedonia or deficits in reward learning, but the relationship between them may be as a result of another factor, such as depression. Theoretically this implies that RNT does not have a negative impact on reward learning, but as the measure of anhedonia in this study does not specifically measure anticipatory or consummatory anhedonia, it cannot answer the question of whether there is a causal relationship between RNT and these concepts. However, the pattern of findings warrants future research to determine whether RNT is a mechanism underpinning anhedonia. In particular, replication of this study using a clinical sample or a sample selected for high depression and worry symptoms would be useful to determine whether the findings are significant in this population. It would also be important in future research to include a manipulation check prior to the reward sensitivity task to ensure that examination of the effects of the manipulation prior to and during the task can be carried out.

The findings from the current study do not provide a conclusive argument in support of the theoretical view that RNT causally contributes to anhedonia (Watkins, 2013). The null findings suggest that this hypothesis is not true in relation to reward learning specifically, but does not answer the

question in relation to anticipatory or consummatory anhedonia. There are a number of limitations to this study, thus, further investigation is warranted, particularly using a clinical sample.

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Appendices

Appendix A – Ethics Documentation

Relevant excerpt of ethics application

PROPOSAL TO ETHICS COMMITTEE – SCHOOL OF PSYCHOLOGY

Researchers: Ruth Burrows-Kerr (Trainee Clinical Psychologist) & Professor Ed Watkins (supervisor)

1. Descriptive Title of Project
Repetitive thinking (RT) and responsiveness to rewards

2. Purpose of project and academic rationale
The main purpose of the project is to examine the hypothesis that maladaptive repetitive thinking (RT) is self-maintaining, in part, because it reduces sensitivity to environmental context and contingencies. Research has demonstrated a relationship between major depression and deficits in performance on a task designed to measure responsiveness to contingencies, i.e., participants' propensity to modulate behaviour as a function of reward (e.g., Pizzagalli, Iosifescu, Hallett, Ratner & Fava, 2009). These studies have found that depressed individuals, compared to normal controls, show a deficit in modulating their behaviour according to contingencies of positive reinforcement during the task. One possible mechanism behind this relationship is that elevated, maladaptive repetitive thinking (RT) in individuals with major depression blocks effective detection of these contingencies. The current project is designed to examine the hypothesis that pathological RT can lead to reduced sensitivity to reward contingencies. The project represents a first step in examining whether maladaptive RT reduces sensitivity to environmental context and contingencies.
In order to assess participants´ sensitivity to environmental contingencies, an experimental task developed by Pizzagalli, Jahn and O'Shea (2005) will be used. The Pizzagalli signal detection task is a computerized task that allows for the objective assessment of the subject's propensity to modulate behaviour as a function of prior reinforcements. Prior to the experimental task, participants will be induced to engage in either unconstructive or constructive forms of RT by instructing them to either think about a problem they currently have and bothered by (unconstructive RT), or a problem they have solved and not bothered by anymore (constructive RT). Participants will be randomized to these two conditions.

3. Methods and measurements
Participants will be asked to complete the following questionnaires and tasks during the experiment. The measures will be presented before, during and after the experiment.

- *The Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996).* The BDI-II is a 21-item self-report measure designed to assess the severity of depressive symptoms. Higher scores represent greater severity of depressive symptoms (scores range 0-63).

- *The Ruminative Responses Scale (RRS; Nolen-Hoeksema, 1991).* The RRS is a 22-item measure of depressive rumination.
- *The Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger & Borkovec, 1990).* The PSWQ.is a 16-item self-report measure of worry phenomena.
- *Mood scale.* Participants will be asked to rate their current mood using a bipolar visual analogue scale (1 = sad, 5 = neutral, 9 =happy).
- *Tension scale.* Participants will be asked to rate their current level of tension using a bipolar visual analogue scale (1 = tense/aroused, 9 = calm/tense).
- *Self-focus scale.* Participants will be asked to rate their current level of self-focus using a visual analogue scale (1= not at all focused on self, 9 = extremely focused on self). See Appendix A for all above measures.
- *Repetitive thinking (RT) task.* The RT task is adapted from a worry induction procedure used by Behar, Zuellig and Borkovec (2005). Participants will be instructed to think about an ongoing and unresolved concern that has been repeatedly coming in to their mind over the past week and causing them to feel negative, sad, down, stressed or anxious. Participants will be given examples of appropriate topics, and asked to briefly outline the topic that they have identified and to indicate how much they have been thinking about this concern over the past week and the extent to which it has troubled them (1) in the past week and (2) at its worst (see Appendix A, Concern Rating). Participants will then be asked to dwell on this current problem or concern, in the way that they would usually dwell on, ruminate or worry about unresolved concerns. The participant will be presented with a series of prompts to focus on various aspects of the concern in turn and left alone for 10 minutes to work through these.
  A matched control (adaptive form of RT) task will ask participants to spend the same period of time thinking about a concern that has previously troubled them and caused them to feel negative, sad, down, stressed or anxious, but that has now been resolved. As in the maladaptive RT condition, participants will be asked to outline the topic, and rate the extent to which it has troubled them during the past week. Before and after completing these tasks participants will be asked to rate their current mood, level of tension and self-focus using visual analogue scales (as described above). Furthermore, after the task, participants will be asked to rate the content of their thinking during the task, including whether they identify this as rumination or worry (see Appendix A, Evaluation of RT after manipulation).
- *Experimental Task: Probabilistic reward task (Pizzagalli, Jahn & O'Shea, 2005)*. The probabilistic reward task developed by Pizzagalli and colleagues is a computerized task that allows for the objective assessment of the subject's propensity to modulate behaviour as a function of prior reinforcements. Subjects are asked to select whether stimulus A or stimulus B was presented by pressing a designated key on the keyboard. Performance can be analyzed with respect to response bias, which reflects the participant's propensity to select one or the other response irrespective of stimulus presentation. A large body of research has shown that by rewarding the correct identification of stimulus A over stimulus B

produces a systematic preference for identifying a stimulus as being A (Macmillan and Creelman, 1991; McCarthy, 1991). Thus, if the probability of reward is greater for correct identification of stimulus A than for stimulus B, then participants will be more likely to respond that a given stimulus is A. Accordingly, the degree of response bias toward the more frequently reinforced response can be used to objectively assess reward responsiveness, in that reduced reward responsiveness will lead to a reduced response bias. In accordance with this, previous studies have found that individuals with major depression show reduced response bias on this task (e.g., Pizzagalli et al., 2009).

In the present study, the subjects' goal will be to determine, via button press, whether a short (11.5 mm) or a long (13 mm) mouth is presented on a previously mouthless cartoon face. The task includes three blocks composed of 100 trials. Within each block an equal number of short and long mouths are presented for 100 ms each. Stimulus exposure (100 ms) and the difference between mouth sizes (11.5 vs. 13 mm) will be identical to those used in prior studies using this paradigm (Pizzagalli, Jahn & O'Shea, 2005). To elicit a response bias, an asymmetric reinforcer ratio will be utilized (McCarthy and Davison, 1979; Tripp and Alsop, 1999). Specifically, correct identification of either the short or long mouth is rewarded (''Correct!! You won 5 pence") three times more often (''rich stimulus") than correct identification of the other mouth (''lean stimulus"). In order for the task to work as intended (induce response bias), subjects will be informed at the beginning of the experiment that the purpose of this task was to win as much money as possible. Moreover, they will be instructed that not all correct responses will receive a reward feedback but will be unaware that one of the stimuli would be disproportionally rewarded. However, all participants will be compensated with either course credits or £5 for their participation. As a manipulation check re the ongoing maintenance of RT, during each break in the probabilistic reward task, participants will be asked to indicate their frequency of thinking about the previous identified concern, current mood and degree of tension and self-focus using a computerized version of the scales completed before and after the RT task. The experimental task is anticipated to take 30-40 minutes to complete.

- *The Autobiographical Memory Questionnaire (AMQ; Rubin, Schrauf & Greenberg, 2003).* The AMQ is a self-report questionnaire of various autobiographical memory characteristics, such as sensory qualities, visual perspective, emotional valence and intensity. Participants will be asked to retrieve the most positive event from their personal past and rate it on selected questions from the AMQ (see Appendix A - AMQ). This task is implemented as a successful means to improve the mood of participants – i.e., as a simple positive mood induction.

4. Participants

University undergraduates and postgraduates will be recruited for both conditions (approx n=45 per condition). All participants will be recruited through the University of Exeter psychology online booking system and emailing the psychology undergraduate and taught postgraduate mailing lists. Participants will be offered course credits or £5 for their time.

Non-fluent English speaking participants will be excluded due to instructions and questionnaires being in English. Due to limited funding it would not be possible to provide a translator. Due to the nature of the rumination task, participants with active suicidal ideation would be excluded (identified using BDI-II and the Mood Disorder Centre (MDC) protocol at the beginning of the experiment).

5. Consent and participant information and debriefing
Intended information and consent forms and debrief attached.

6. Ethical considerations
The main ethical consideration identified is the use of a procedure to prompt rumination, which is expected to cause a temporary worsening of mood. Individuals identified as particularly vulnerable (reporting active suicidal risk – MDC risk protocol to be followed in such cases) will be excluded from the study and participants' mood will be assessed at regular intervals throughout the session. Furthermore, to improve participants' mood at the end of the study, participants will be asked to retrieve and write down the most positive event they have experienced in their lives. This has been shown to repair mood in nondysphoric participants following a negative mood induction (Joorman & Siemer, 2004). Should participants continue to report a substantial decline in mood at the session end a shortened version of Nolen-Hoeksema and Morrow's standard distraction manipulation (known to reduce rumination and temporarily improve low mood) will be administered to alleviate remaining increases in ruminative processing and negative thinking. Should participants express discomfort or distress at any time during the session, the session will be terminated, reassurance offered and the above procedure followed (distraction task). During debriefing all participants will be provided with information regarding sources of help and support, and also reminded of the researchers contact details should any concerns arise subsequent to the session end. Because participants will complete the BDI-II during the session, some participants might be identified as having elevated depressed symptoms – we will be able to provide advice for further referrals for those participants is necessary. The advice for further referrals consists of advising participants who indicate moderate-high levels of depression symptoms, but do not indicate suicide risk that we would advise them to discuss these difficulties/symptoms with their GP if they have not done so already and providing them with information regarding other sources of support. For individuals who indicate suicide risk (who will be informed that the study is not suitable for them, and will not be given the rumination task), the risk protocol will be followed. Where individuals indicate an immediate risk, as a Trainee Clinical Psychologist, I would assess this risk with them and gain the participants consent to contact their GP, or if necessary the crisis resolution team are contacted (cases B and C of the risk protocol attached page 4). I would then discuss this with my supervisor, Ed Watkins.

7. **Estimated start date and duration: November 2013 – November 2014**

Psychology Research Ethics Committee

Psychology, College of Life & Environmental Sciences

Washington Singer Laboratories
Perry Road
Exeter
EX4 4QG

Telephone +44 (0)1392 724611
Fax +44 (0)1392 724623
Email Marilyn.evans@exeter.ac.uk

To: **Ruth Burrows-Kerr**
From: **Cris Burgess**
CC: **Ed Watkins**
Re: **Application 2013/532 Ethics Committee**
Date: **August 19, 2015**

The School of Psychology Ethics Committee has now discussed your application, ***2013/532 – Repetitive thinking (RT) and responsiveness to rewards.*** The project has been approved in principle for the duration of your study.

The agreement of the Committee is subject to your compliance with the British Psychological Society Code of Conduct and the University of Exeter procedures for data protection (http://www.ex.ac.uk/admin/academic/datapro/). In any correspondence with the Ethics Committee about this application, please quote the reference number above.

I wish you every success with your research.

Cris Burgess
Chair of Psychology Research Ethics Committee

Appendix B – RNT Manipulation

Unresolved Goal Condition:

a. *"For the next ten minutes I am going to ask you to close your eyes and focus your attention on a problem and difficulty that is still unresolved and bothering you –so this is an ongoing and unresolved concern that has been repeatedly coming to your mind over the past week and causing you to feel negative, sad, down or stressed.*

b. *When I ask you to begin, please close your eyes and dwell on this current problem or concern, in the way that you usually dwell on and ruminate about unresolved concerns, as intensely as you can, until I ask you to stop and to open your eyes.*

c. *"Examples of the kind of difficulty that I would like you think about are...*

- *An ongoing concern about an important relationship, which you feel you should be managing better.*
- *A recent negative event and its impact upon how you have been feeling over the past few weeks.*
- *Concerns that you have failed to achieve a goal that is of personal importance to you.*
- *Feeling that you disappoint someone who means a lot to you.*
- *Feeling that you do not compare favourably to other people with respect to an area of functioning that is important to you.*

d. *"The problem or difficulty that you think about must be one that has been repeatedly troubling you recently and that you have not resolved, that is, it still bothers you and still comes repeatedly to mind."*

e. *"Can you think of a problem or difficulty of this kind to think about?*(if **no**, try again by going through the examples above – it should be possible to find such an example – only if clear that there is not one then end the study and debrief, if **yes**, continue as follows).

f. *Would you mind telling me very briefly what the problem is?*

g. *Now I would like you to evaluate this difficulty using the following scales.*

h. *"Please close your eyes and dwell on this current problem or concern, in the way that you usually dwell on and worry about unresolved concerns, as intensely as you can, until I ask you to stop and to open your eyes.*

   i. *Think about the problem and difficulty – what is it?*
   ii. *Focus on what about this problem/difficulty bothers and troubles you.*
   iii. *Think about what is important about this difficulty in terms of your personal goals.*
   iv. *Focus on how this problem reflects a lack of progress on important personal goals.*
   v. *Think about how the problem/difficulty is still unresolved.*

vi. *Concentrate on the aspects of the problem that reflect unfinished business*

vii. *Focus on the aspects of the difficulty that repeatedly come to mind.*

viii. *Think about any related concerns and unresolved issues that this problem reminds you of.*

i. *"Please continue doing this until I come back".*

Resolved Goal Condition:

a. *"For the next ten minutes I am going to ask you to close your eyes and focus your attention on a recent problem or difficulty that is now resolved and no longer bothering you –so this is a past and resolved difficulty that has not been coming in to your mind over the past week and no longer causes you to feel negative, sad, down, stressed or anxious.*

b. *When I ask you to begin, please close your eyes and think about this past problem or concern, in the way that you usually think about resolved concerns, as intensely as you can, until I ask you to stop and to open your eyes.*

c. *"Examples of the kind of difficulty that I would like you think about are...*

- *A concern that you would not achieve a goal that you have now succeeded in achieving.*
- *A past dispute with someone who means a lot to you that has now been resolved and you now feel very positively about this relationship.*
- *A situation or event that you had been finding stressful, but that you have now learned to manage well.*
- *An area of functioning that is important to you, and which you previously felt you did not manage well, but that you now manage as well as other people.*
- *A negative event that happened may years ago and that you have now come to terms with and are not troubled by.*

d. *"The problem or difficulty that you think about must be one that has not been troubling you recently and that you have now resolved.*

e. *"Can you think of a problem or difficulty of this kind to think about?(if **no,** try again by going through the examples above – it should be possible to find such an example – only if clear that there is not one then end the study and debrief, if **yes,** continue as follows).*

f. *Would you mind telling me very briefly what the problem is?*

g. *Now I would like you to evaluate this difficulty using the following scales.*

h. *Please close your eyes and think about this past problem or concern, in the way that you usually think about past resolved difficulties, as intensely as you can, until I ask you to stop and to open your eyes."*

i. *Think about the problem and difficulty – what was it?*
ii. *Focus on what about this problem/difficulty bothered and troubled you in the past.*
iii. *Think about what was important about this difficulty in terms of your personal goals.*
iv. *Focus on how resolving this problem reflects progress on important personal goals.*
v. *Think about how the problem/difficulty is now resolved.*
vi. *Concentrate on the aspects of the problem that are now finished and dealt with*
vii. *Think about any other resolved difficulties that this problem reminds you of.*

i. *"Please continue doing this until I come back".*

Appendix C – PHQ-9

Patient Health Questionnaire (PHQ 9)

Over the *last 2 weeks*, how often have you been bothered by any of the following problems?

		Not at all	Several days	More than half the days	Nearly everyday
1	Little interest or pleasure in doing things	0	1	2	3
2	Feeling down, depressed, or hopeless	0	1	2	3
3	Trouble falling/staying asleep, sleeping too much	0	1	2	3
4	Feeling tired or having little energy	0	1	2	3
5	Poor appetite or overeating	0	1	2	3
6	Feeling bad about yourself – or that you are a failure or have let yourself or your family down	0	1	2	3
7	Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8	Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9	Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

Appendix D – Concern Rating Likert-Type Scales

Concern Rating

Please evaluate **the difficulty that you have just identified** using the following scales:

1. Please rate, on a 1–9 scale, **how important this problem is to you**, where 1 = 'not at all important', and 9 = 'extremely important'.

1 2 3 4 5 6 7 8 9

Not at all important — Extremely important

2. Please rate, on a 1–9 scale, **how much this problem bothered you when it was at its worst**, where 1 = 'I was not at all troubled by it', and 9 = 'I was extremely troubled by it'.

1 2 3 4 5 6 7 8 9

Not at all troubled by this difficulty — Extremely troubled by this difficulty

3. Please rate, on a 1–9 scale, **how much this problem bothers you now**, where 1 = 'I am not at all troubled by it', and 9 = 'I am extremely troubled by it'.

1 2 3 4 5 6 7 8 9

Not at all troubled by this difficulty — Extremely troubled by this difficulty

4. Please rate, on a 1–9 scale, **how frequently you have thought about the difficulty over the past week including today**, where 1 = 'I almost never thought of it', and 9 = 'I almost always thought about it'.

1 2 3 4 5 6 7 8 9

Almost never — Sometimes — Often — Almost always

5. Please indicate, on a 1-100% scale **how much control you felt over thinking about this difficulty over the past week including today**, where 0 = 'no control, I thought about it automatically', and 100% = 'complete control, I only thought about it when I wanted to think about it'.

0 50 100

No control Moderate control Complete control

6. Please rate, on a 1-9 scale, **how easily you have found it to dismiss thinking about this difficulty during the last week including today**, where 1 = 'very easy to dismiss', and 9 = 'very hard to dismiss'.

1 2 3 4 5 6 7 8 9

Very easy Neither easy nor difficult Very hard

7. Please rate, on a 1–9 scale, **how much does this difficulty relate to more general concerns or problems that you have**, where 1 = 'it is not at all related to other concerns', and 9 = 'it is extremely related to other concerns'.

1 2 3 4 5 6 7 8 9

Not at all related Extremely related

8. Please indicate in weeks **how long this difficulty has been a concern for you.**

Appendix E – Mood, Tension & Self-Focus Likert-Type Scales

1. Please rate, on a 1–9 scale, **how you are feeling right now**, where 1 = 'I feel very sad', 5 = 'I feel neither sad or happy' and 9 = 'I feel very happy'.

1 2 3 4 5 6 7 8 9

Very sad Neutral mood Very happy

2. Please rate, on a 1–9 scale, **how you are feeling right now**, where 1 = 'I feel very tense or aroused', and 9 = 'I feel very calm and relaxed'.

1 2 3 4 5 6 7 8 9

Very Tense/aroused Neither calm nor tense Very calm/relaxed

3 Please rate, on a 1–9 scale, **how you are feeling right now**, where 1 = 'I am not at all focused on myself', and 9 = 'I am extremely focused on myself'.

1 2 3 4 5 6 7 8 9

Not at all focused on myself Extremely focused on myself

Appendix F – RNT Manipulation Check Likert-Type Scales

Evaluation of RT at each break of the computer task

1) Please rate how frequently you thought about your identified problem (from the task that involved thinking about a personal concern before) during the last block of the perception task where 1 = 'I almost never thought of it', and 9 = 'I almost always thought of it'?

1	2	3	4	5	6	7	8	9
Almost Never		Sometimes			Often		Almost Always	

2) During the last block of the perception task if thoughts about the identified problem came to mind, how long did they typically last where 1 = 'only moments' and 9 = 'nearly all the time available'?

1	2	3	4	5	6	7	8	9
Only moments		A few minutes			For many Minutes		Nearly all the time available	

3) During the last block of the perception task if thoughts about the identified problem came to mind, how much did you come back to the same or similar ideas again and again where 1 = 'almost never' and 9 = 'almost always'?

1	2	3	4	5	6	7	8	9
Almost Never		Sometimes			Often		Almost Always	

4) During the last block of the perception task if thoughts about the identified problem came to mind, did you find it hard to stop the thoughts coming or to move on other thoughts/activities, where 1 = 'almost never' and 9 = 'almost always'?

1	2	3	4	5	6	7	8	9
Almost Never		Sometimes			Often		Almost Always	

5) During the last block of the perception task when/if thoughts about the identified problem came to mind, how upsetting or distressing did you find the thoughts, where 1 = 'not at all distressing' and 9 = 'extremely distressing'?

1	2	3	4	5	6	7	8	9
Not at all distressing			Moderately distressing				Extremely distressing	

Appendix G – RSQ

Responses to Depression

People think and do many different things when they feel down, sad or depressed. Please read each of the items below and indicate whether you never, sometimes, often, or always think or do each one when you feel down, sad or depressed. Please indicate what you *generally* do, not what you think you should do.

	Almost Never	Some-times	Often	Almost Always
1. Think about how alone you feel.				
2. Think "I won't be able to do my job/work because I feel so bad"				
3. Think about your feelings of fatigue and achiness				
4. Think about how hard it is to concentrate				
5. Think about how passive and unmotivated you feel				
6. Analyse recent events to try and understand why you are depressed.				
7. Think about how you don't seem to feel anything anymore				
8. Think "Why can't I get going?"				
9. Think "Why do I always react this way?"				
10. Go away by yourself and think about why you feel this way				
11. Write down what you are thinking about and analyse it				
12. Think about a recent situation, wishing it would have gone better				
13. Think "Why do I have problems other people don't have?"				
14. Think about how sad you feel				
15. Think about all your shortcomings, failings, faults and mistakes				
16. Think about how you don't feel up to doing anything				
17. Analyse your personality to try and understand why you are depressed				
18. Go someplace alone to think about your feelings				
19. Think about how angry you are with yourself				
20. Listen to sad music				
21. Isolate yourself and think about the reasons why you feel sad				
22. Try to understand yourself by focusing on your depressed mood				
23. Think "What am I doing to deserve this?"				
24. Think "I won't be able to concentrate if I keep feeling this way".				
25. Think "Why can't I handle things better?"				

Thank you for filling in this questionnaire.

Appendix H – PSWQ

The Penn State Worry Questionnaire (PSWQ)

Instructions: Rate each of the following statements on a scale of 1 (“not at all typical of me”) to 5 (“very typical of me”). Please do not leave any items blank.

	Not at all typical of me	Slightly typical of me	Moderately typical of me	Mainly typical of me	Very typical of me
1. If I do not have enough time to do everything, I do not worry about it.	1	2	3	4	5
2. My worries overwhelm me.	1	2	3	4	5
3. I do not tend to worry about things.	1	2	3	4	5
4. Many situations make me worry.	1	2	3	4	5
5. I know I should not worry about things, but I just cannot help it.	1	2	3	4	5
6. When I am under pressure I worry a lot.	1	2	3	4	5
7. I am always worrying about something.	1	2	3	4	5
8. I find it easy to dismiss worrisome thoughts.	1	2	3	4	5
9. As soon as I finish one task, I start to worry about everything else I have to do.	1	2	3	4	5
10. I never worry about anything.	1	2	3	4	5
11. When there is nothing more I can do about a concern, I do not worry about it anymore.	1	2	3	4	5
12. I have been a worrier all my life.	1	2	3	4	5
13. I notice that I have been worrying about things.	1	2	3	4	5
14. Once I start worrying, I cannot stop.	1	2	3	4	5
15. I worry all the time.	1	2	3	4	5
16. I worry about projects until they are all done.	1	2	3	4	5

Appendix I – AMQ

AMQ

Think back to the **most positive** event you have experienced in your life and answer the following questions as honestly as you can.

1) **Describe** the event in detail, as you would describe it to a friend:

2) While remembering the event, I feel as though I am **reliving** it:

Not at all 1 2 3 4 5 6 7 As clearly as if it were happening now

3) While remembering the event, it comes to me in words or in pictures **as a coherent story** or episode and not as an isolated fact, observation, or scene:

Not at all 1 2 3 4 5 6 7 Completely

4) While remembering the event, I can **see** it in my mind:

Not at all 1 2 3 4 5 6 7 As clearly as if it were happening now

5) While remembering the event, I can **hear** it in my mind:

Not at all 1 2 3 4 5 6 7 As clearly as if it were happening now

6) While remembering the event, I know the **setting** where it occurred:

Not at all 1 2 3 4 5 6 7 As clearly as if it were happening now

7) As I think about the event, I can actually **remember** it rather than just knowing that it happened:

Not at all 1 2 3 4 5 6 7 Completely

8) While remembering the event, I feel that I see it out of **my own eyes** rather than that of an outside observer:

Not at all 1 2 3 4 5 6 7 Completely

9) While remembering the event, I feel that I see it as an **outside observer** might see it, rather than out of my own eyes:

Not at all 1 2 3 4 5 6 7 Completely

10) While remembering the event, I feel the **same particular emotions** I felt at the time of the event.

Completely different 1 2 3 4 5 6 7 Identically the same

11) While remembering the event, the emotions that I feel are **extremely intense***:*

Not at all 1 2 3 4 5 6 7 Entirely

12) While remembering the event, I feel the **emotions as strongly** as I did then:

Not at all 1 2 3 4 5 6 7 As clearly as if it were happening now

13) While remembering the event, the emotions are **extremely positive***:*

Not at all 1 2 3 4 5 6 7 Entirely

14) While remembering the event, the emotions are **extremely negative***:*

Not at all 1 2 3 4 5 6 7 Entirely

15) My memory comes in **pieces** with missing bits.

Not at all 1 2 3 4 5 6 7 Completely

16) While remembering the event, I experience **physical reactions:**

Not at all 1 2 3 4 5 6 7 Very much so

16b) Please state **which physical reactions** you experienced, if any:

17) The memory is about an event that has become central to my **life story**:

Not at all 1 2 3 4 5 6 7 Very much so

18) The memory is about an event that has become central to my **identity**:

Not at all 1 2 3 4 5 6 7 Very much so

19) The memory is about an event that is **important** to my life:

Not at all 1 2 3 4 5 6 7 Very much so

20) How **old** are you in the memory? _____years

20a) If you stated your current age in question 20), approximately how many **days from today** does the event date back? Approx. _____days

Appendix J – Information Sheet

SCHOOL OF PSYCHOLOGY

Study Information Sheet

Descriptive Title of Project

Imagery ability and visual perception.

Researchers:

Ruth Burrows-Kerr: Trainee Clinical Psychologist
Professor Ed Watkins: supervisor

Location:

School of Psychology
University of Exeter
Washington Singer Building
Perry Rd
Exeter EX4 4QG
01392 264645

WHO IS ORGANISING THIS RESEARCH?
This research is being conducted by a Trainee Clinical Psychology student, as fulfilment for the research element of the Doctorate in Clinical Psychology at Exeter University. The Psychology department is committed to conducting research to promote practice and research to benefit those with psychological issues.

WHAT THE STUDY IS ABOUT
In this study we are interested in examining imagery ability, mood and visual perception in an experimental context. We are investigating the interaction between imagery ability and visual perception, to see whether these processes are related to each other in terms of individual differences. We will also measure some cognitive and personality variables that might influence this interaction.

WHAT IS INVOLVED IN TAKING PART?
The study takes place in the Mood Disorders Centre, and involves attending a single session, which will take approximately one hour.

In the session you will be asked to fill out a questionnaire that asks about various aspects of your mood and personality. Some of the questions on these questionnaires ask about personal issues and symptoms. Because these questions can occasionally highlight personal difficulties, we will provide contact details of where participants can seek more help or information if relevant. As a Trainee Clinical Psychologist, the experimenter will be able to provide further advice if necessary, or seek further support from the supervisor, Prof Ed Watkins, a trained clinical psychologist.

Thereafter I will ask you to identify and spend ten minutes imagining a recent problem or difficulty. This may produce a temporary, brief, increase in low

mood in some, but not all people. Following that you will be asked to complete the task that we are using to examine the relationship between mood, imagery ability and visual perception. The task is on the computer and it involves paying attention to what is presented on the screen – you have to press one button when a face presented on the screen has a little mouth and another key when the face presented has a big mouth. Thereafter, I will ask you to fill out a questionnaire asking you about your various aspects of your personality. Finally I will ask you to retrieve an event from your personal past and while holding that event in mind, answer a few questions to assess your visual imagery.

WHAT WILL HAPPEN TO THE INFORMATION YOU GIVE?
All the information that you provide will be kept in a secure place and will remain confidential. You are free not to answer any particular question if you do not wish to do so. Your answers to the questionnaires and all data gathered by the computer will be identifiable only through an ID number (and not your name). No one else will see this data apart from the research team and we will not communicate any of this information to anybody else. Your name and contact details will be stored separately from any personal information that you provide on the questionnaires.

At the start of the study, you will be asked to complete a questionnaire on how you have been feeling for the past two weeks, including thoughts or intentions of suicide. The experimenter will check those answers before proceeding with the study. In the rare case that participants indicate they might be a threat to themselves, the researcher will stop the study and ask questions to assess potential risk. Depending on that assessment, the experimenter might have to contact the person's GP and in some cases a crisis management team. This is done as a part of ethical research guidelines and will only be done in those rare cases when considered necessary.

WHAT WILL HAPPEN TO THE RESULTS OF THE STUDY
The study findings will be written up and reported (a thesis) in part completion of a Doctorate in Clinical Psychology. In accordance with University of Exeter Open Research Exeter policy, the thesis will be stored electronically at the University of Exeter, and will be accessible online (open access). The study findings might also be written up for publication in research journals and presented at conferences. The published journal article will also be available online (open access, University of Exeter). These research reports and presentations will not contain any identifiable information about you.

For More Information Contact:

Ruth Burrows-Kerr
Trainee Clinical Psychologist
rb403@exeter.ac.uk

Professor Edward Watkins
e.r.watkins@exeter.ac.uk

THANK YOU FOR READING THIS INFORMATION SHEET

Appendix K – Consent Form

SCHOOL OF PSYCHOLOGY

CONSENT FORM

Imagery ability and visual perception

Name of Researchers: Dr Ed Watkins, Professor in Clinical Psychology
Ruth Burrows-Kerr, Trainee Clinical Psychologist

Please tick box if you agree with the statement

1. After reading the Study Information Sheet for the above study I agree to take part. I have had the opportunity to ask questions.

☐

2. I understand that my participation is voluntary and that I am free to leave the experiment at any time, without needing to give a reason.

☐

Would you be willing to be contacted regarding other research that is being conducted in the mood disorders centre?

Yes ☐ No ☐

_____ _____ _____

Participant signature Date Print name

_____ _____ _____

Researcher signature Date Print name

Appendix L – Demographics Questionnaire

Demographics questionnaire

Age: ____years

Gender: ___male, ___female

Ethnicity:_____

Education:_____

Handedness: ___left handed, ___right handed

Native Language:_____

Occupation:_____

Appendix M – Sources of Help

Sources of help

If you feel like you are experiencing low or negative mood and would like more information about how to get some help we recommend that you talk to your own doctor. They are able to provide information about the resources and treatments available in your local area. Here are some links which you may find helpful:

Wellbeing Services

Wellbeing Services are here to help students get the most out of their time at University. Health and wellbeing are crucial ingredients of effective study as well as a rich and fulfilling student experience. But staying well in body and mind isn't always easy at university. We recognise that it's much more difficult to learn and enjoy student life when personal difficulties or emotional worries arise.

Sometimes we need a little help to get "back on track" when particular concerns begin to affect us, and our Wellbeing Team can offer a range of services to support students personally and in their studies when difficulties occur.

Appointments can be booked :

Login to the My Exeter Portal - click on the Help and Support tab and select the link to 'log a new enquiry' with the Student Information Desk. Then hover over the Health and Wellbeing category and complete the **appointments form**. (Please note that from this point onwards your enquiry remains confidential to the Wellbeing Services team). As soon as we receive this form we will be pleased to book an appointment for you.

drop in at the wellbeing centre
telephone: (01392) 724381
email wellbeing@exeter.ac.uk

http://as.exeter.ac.uk/wellbeing/

Wellbeing Service (term-time opening hours: 9am – 5pm)
Reed Mews Wellbeing Centre
University of Exeter
Streatham Drive
Exeter
EX4 4QP

VOICE (UNIVERSITY OF EXETER)

Voice is a student run listening and information service, run by students for the students at the University of Exeter and is available from 8pm to 8am every night during term time. It is completely confidential, anonymous and prejudice free, which means you can call with the confidence of knowing that you can discuss anything you want without being judged. They are willing to talk to you about any personal problems that you might have. If you are feeling sad, happy, stressed, blue, lost, or worried, then Nightline is only a call away.

Telephone: 74000 (internal, free of charge) / 01392 275284 (8pm – 8am)
Mobile: 01392 275 284
Email / Skype voicemail@exetervoice.co.uk

SAMARITANS
Samaritans provides confidential emotional support, 24 hours a day for people who are experiencing feelings of distress or despair. Samaritans are there if you're worried about something, feel upset or confused, or you just want to talk to someone.

24 hour telephone helpline: (08457) 90 90 90 (national number) or (01392) 411711

Email help service: jo@samaritans.org

10 Richmond Road
Exeter
Devon
EX4 4JA (10.30am - 9.30pm Mon – Sat, 4.30pm – 9.30pm Sun)

http://www.samaritans.org/

DEPRESSION ALLIANCE
Depression Alliance are a charity working to relieve and to prevent depression by providing information, support and understanding. Depression Alliance offer a range of publications, self-help groups and an information telephone line.

Tel: 0845 123 23 20

Depression Alliance
212 Spitfire Studios
63 - 71 Collier Street
London
N1 9BE

http://www.depressionalliance.org/

Talking to your doctor about depression

http://www.depressionalliance.org/help-and-information/working-with-your-doctor.php

http://www.anxietyuk.org.uk/

Saneline; help line for people with mental health difficulties

http://www.sane.org.uk/SANEline

The royal college of psychiatrists mental health information

http://www.rcpsych.ac.uk/mentalhealthinfoforall.aspx

American Psychological Association

http://www.apa.org/

British Psychological Society

http://www.bps.org.uk/

Useful self-help **books** for depression that are widely available include:

Greenberger, D. & Padesky, C. A. (1995). Mind over mood: Change how you feel by changing the way you think. New York: Guilford.

McDonnell, F. (2003). Threads of hope: Learning to live with depression. A collection of writing. London: Short Books.

Gilbert, P. (1995). Overcoming Depression: a Self-help Guide Using Cognitive Behavioral Techniques. Robinson Publishing.

We also recommend the **website** http://www.livinglifetothefull.com/ which is a freely available web-based course in self-help skills to manage depression.

We are not responsible for the content available on any of the links or resources provided above.

Appendix N: Dissemination Statement

Dissemination Statement

I will use the following dissemination strategy to ensure that the findings of this research are shared with interested parties.

University of Exeter Doctorate in Clinical Psychology

This thesis will be submitted as part of the requirements of the doctorate programme.

Wider Academic and Clinical Community

I will be presenting to Trainee Clinical Psychologists, staff and other interested parties at the University of Exeter in June 2014.

As per ethical approval, participants who provided an email address on their consent form and requested a copy of the results will be sent a summary of the study findings.

I intend on submitting a reduced research paper for publication in a peer-reviewed journal (Journal of Experimental Psychopathology).

Appendix O: Author Guidelines

Journal of Experimental Psychopathology
Guidelines for Authors
Scope of the Journal

The ***Journal of Experimental Psychopathology*** is an e-journal created to publish cutting-edge original contributions to scientific knowledge in the general area of psychopathology. Although there will be an emphasis on publishing research which has adopted an experimental approach to describing and understanding psychopathology, the journal will also welcome submissions that make significant contributions to knowledge using other empirical methods such as correlational designs, meta-analyses, epidemiological and prospective approaches, and single-case experiments. Theoretical and review articles addressing significant issues in the description, aetiology, and treatment of psychopathologies are also welcome.

The Editors and Associate Editors will make an initial determination of whether or not submissions fall within the scope of the journal and are of sufficient merit and importance to warrant full review.

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Authors should submit their manuscript electronically via the journal's editorial system (http//jep.textrum.com/). Your manuscript will then be allocated to an Associate Editor who will manage the peer review process. You should retain an editable version of your paper in WORD or similar format because this may be needed for further processing should your manuscript be accepted for publication.

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Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the Editors.

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The manuscript should follow American Psychological Association (APA) publication manual guidelines. All pages should be typed double-spaced and numbered (including pages containing the title, authors names and affiliation footnotes, abstract, acknowledgments, references, tables, and figure caption list).

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